GREAT LAKES INDIAN FISH & WILDLIFE COMMISSION
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• MEMBER TRIBES •

MICHIGAN	WISCONSIN		MINNESOTA
Bay Mills Community	Bad River Band	Red Cliff Band	Fond du Lac Band
Keweenaw Bay Community	Lac Courte Oreilles Band	St. Croix Chippewa	Mille Lacs Band
Lac Vieux Desert Band	Lac du Flambeau Band	Sokaogon Chippewa	

December 16, 2015

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GLIFWC Comments on the Adequacy of the NorthMet Final Environmental Impact Statement (FEIS) and Notice of 404 Permitting

Mr. Jimenez, Mr. Bruner and Ms. Fey,

Enclosed please find the comments of Great Lakes Indian Fish and Wildlife Commission (GLIFWC) staff on the Final Environmental Impact Statement (FEIS) and Notice of 404 Permitting for the proposed NorthMet project. GLIFWC is an intertribal agency exercising delegated authority from 11 federally recognized Ojibwe (or Chippewa) tribes in Wisconsin, Michigan and Minnesota.[1] Those tribes have reserved hunting, fishing and gathering rights in

[1] GLIFWC member tribes are: in Wisconsin -- the Bad River Band of the Lake Superior Tribe of Chippewa Indians, Lac du Flambeau Band of Lake Superior Chippewa Indians, Lac Courte Oreilles Band of Lake Superior Chippewa Indians, St. Croix Chippewa Indians of Wisconsin, Sokaogon Chippewa Community of the Mole Lake Band, and Red Cliff Band of Lake Superior

territories ceded in various treaties with the United States. GLIFWC's mission is to assist its member tribes in the conservation and management of natural resources and to protect habitats and ecosystems that support those resources.

As you know, the proposed NorthMet Mine is located within the territory ceded in the Treaty of 1854. GLIFWC member tribes have expressed concern about the potential impacts of sulfide mining, whether those impacts occur within the 1854 ceded territory, in the 1842 ceded territory, which includes portions of Lake Superior, or the 1837 ceded territory. The following comments are submitted by GLIFWC staff with the explicit understanding that each GLIFWC member tribe or any other tribe may choose to submit comments from its own perspective.

GLIFWC staff have developed expertise on assessing the impact of mining projects through work on a number of proposed and operating metallic mining projects in the Lake Superior region. These projects include the proposed Crandon Mine, Flambeau Mine, Eagle Mine, proposed Copperwood Mine, and proposed Penokee Mine. Based on this expertise, GLIFWC staff have communicated a variety of technical concerns to the lead agencies on the scientific adequacy of the EIS resource areas that include water quantity, water quality, modeling, wetlands, mercury, and cumulative impacts. These concerns are documented in comments provided during our review of the Complete Pre-Draft Environmental Impact Statement of 2008 (CPDEIS), the Draft Environmental Impact Statement of 2009 (DEIS), the Pre-Supplemental Draft Environmental Impact Statement of 2013 (PSDEIS), the Supplemental Draft Environmental Impact Statement of 2014 (SDEIS), and the Pre-Final Draft Environmental Impact Statement of June 2015 (PFEIS). In addition to these comments, GLIFWC staff participated in several IAP groups that were formed after the 2009 DEIS was determined to be inadequate. Staff have also attempted to communicate issues through stand alone comment letters and emails to the lead agencies on the topics previously discussed. Unfortunately, the majority of issues that we raised in 2008 remain unresolved in the 2015 FEIS.

The FEIS is inadequate in several areas. The shortcomings in accuracy and precision of the information and predictions contained in the FEIS with regards to modeling, water quantity, water quality, and wetlands render the document unfit for use in the subsequent permitting process. The FEIS attempts to overcome these shortcomings by invoking the use of adaptive management language. NEPA requires scientifically defensible science to drive conclusions regarding the potential impacts of the proposed action. Adaptive management is a useful tool but it cannot be used in lieu of analysis during the federal EIS process. By relying so heavily on adaptive management, the FEIS does not fully explore avoidance and minimization in the analysis but moves directly into mitigation of impacts after they have already begun to occur.

Chippewa Indians; in Minnesota -- Fond du Lac Chippewa Tribe, and Mille Lacs Band of Chippewa Indians; and in Michigan -- Bay Mills Indian Community, Keweenaw Bay Indian Community, and Lac Vieux Desert Band of Lake Superior Chippewa Indians.

Improper Use of Adaptive Management

The FEIS has adopted the term "adaptive management" to describe monitoring and potential future mitigation actions that would be implemented on an as needed basis. We agree that adaptive management is an important part of a mine project but it is intended to address unforeseen impacts only. The FEIS uses adaptive management for areas for areas in which the FEIS does not make reliable predictions about environmental impacts. As we have repeatedly stated, monitoring does not prevent mine related environmental impacts. Monitoring can only detect impacts after they have begun to occur and the adaptive management activities that are listed in the FEIS would only be a reaction to an impact that has already begun to occur.

In contrast, a federal EIS document is not reactive but forward looking. The purpose of an EIS is to identify all reasonably foreseeable impacts and scientifically characterize them so that decision makers can evaluate the cost and benefits of a proposed action. The EIS does have the additional purpose of identifying mitigation and monitoring activities but this task does not obviate the need for meaningful and scientifically defensible predictions and characterizations of expected impacts. The FEIS has failed to adequately define the impacts (costs) of the proposed PolyMet project in several critical areas. Therefore, decision makers will not have the information they need to make informed decisions.

In comments provided for the 2009 DEIS GLIFWC staff state:

> *"GLIFWC staff object to the way in which monitoring is used in this DEIS. As previously stated, the DEIS does not include vital information needed for impact characterization. Instead, the DEIS proposed to substitute monitoring of the project for an analysis that can be included in the DEIS. For example, the complete extent of indirect wetland impacts has not been determined. The DEIS acknowledges that some indirect wetland impacts will occur in addition to those impact identified in the document. The DEIS states that a wetland monitoring system will be used to detect impacts after the project is underway. This method is not acceptable to GLIFWC and does not meet the intent of NEPA."*

The FEIS has the same deficiencies. Adaptive management is improperly used in place of impact prediction in many areas including geotechnical stability of the tailings facilities, cumulative effects analysis, water treatment facilities, wetland restoration, mercury reduction, etc. Two important examples are expanded upon below.

1. Indirect Wetland Impacts. The approach used in the analysis of indirect wetland impacts in the FEIS is different from the 2009 DEIS and the 2014 SDEIS. GLIFWC staff commented in the past that the 2009/2014 analog approach was overly simplistic. The new approach in the current FEIS appears to be almost completely relying on adaptive management. The FEIS states:

"Indirect effect analyses performed for the EIS were not performed to characterize impacts but were done to inform where monitoring should take place for those areas that were identified as having a potential for indirect wetland effects." (FEIS page 5-259)

The 2009/2014 analog approach was previously chosen by the lead agencies because they contended that a more quantitative method based on MODFLOW groundwater modeling and field collected data would not yield information useful to assess indirect impacts. GLIFWC staff disagree with this contention (see indirect wetland impact section). A site specific MODFLOW model that incorporates existing information could provide reasonable estimates of the potentiometric surface (water table). The model could then be stressed by incorporating the proposed PolyMet Mine pits and the neighboring Northshore Mine pits and reasonable estimates of drawdown under the wetlands could be developed. The development of this model, including field data collection to support it, could have been accomplished in far less than the 8 years the EIS process for this project has lasted. Groundwater models, using the MODFLOW software, are standard techniques for assessing groundwater impacts of proposed mines at newly proposed projects across the country. Statements in the FEIS regarding the complexity of the site and the impossibility of successfully modeling water table drawdown cannot be supported.

GLIFWC staff disagree with further simplification of the indirect wetland impact analysis. This approach relies on monitoring that by definition would detect impacts after they have already begun to occur. Only then would adaptive management techniques be used to attempt to mitigate the damage. This approach is contrary to the goals of the NEPA process, which is designed to be forward looking.

2. Mine Site Groundwater Movement. According to the co-lead agency memo of June 22, 2015, it is not possible to rule out a northward bedrock flowpath from the proposed NorthMet pits to the Northshore pits during the closure period and beyond (MODFLOW Teleconference of July 2015 and Draft Interagency Memorandum: Co-Lead Agencies' Consideration of Possible Mine Site Bedrock Flowpath, June 22, 2015). The results of both complex (MODFLOW) and simplistic (ERM's MathCad) modeling of flow direction indicate that there will in fact be a northward flowpath. The existence of a bedrock groundwater mound that would prevent a northward flowpath, is not plausible given the hydrogeology of the site. Adaptive management cannot be a substitute for understanding the hydrology of a northward flowpath through the development of an analytical model based on site data and a consistent conceptual model. Such an understanding would provide critical information on contaminant flow paths and travel times of contaminants to the north as well as to the Partridge River. The current proposal to have a system of monitoring wells that could detect contaminants moving out of the mine pits is appropriate, but is not a substitute for understanding and predicting the scope of potential impacts. Only with an understanding of the site hydrology and the potential impacts can the feasibility of mitigation measures be evaluated.

GLIFWC disagree with this adaptive management approach and maintain that the FEIS is inadequate. A defensible, site specific groundwater model, based on a consistent

conceptualization of the site hydrology should be used to characterize site hydrology, understand the effects of the PolyMet project and its interactions with adjacent projects and define contaminant flows.

Perpetual Maintenance and Water Treatment at the NorthMet Project

The analysis conducted in support of the proposed mine is inadequate in that it fails to predict the length of time that water treatment would be required in order to avoid exceedance of water quality standards.

The lead agencies position on post closure maintenance and water treatment needs in the SDEIS states:

"Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum of 200 years at the mine site and 500 years at the plant site. While long term, these time frames for water treatment are not necessarily perpetual. The owning company would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met"

In the FEIS the language has been changed to:

> *"Water quality modeling performed in support of the FEIS indicates that water treatment systems in some form and at some scale would be needed at the Mine Site and Plant Site indefinitely"*

GLIFWC staff agree that the statement above is accurate however we note that it is not very informative. The bottom line is that the FEIS does not predict how long water treatment will be needed for this project. Tribal cooperating agencies and intertribal agencies requested that this analysis be done but the co-lead agencies denied that request. This lack of knowledge has serious implications on financial assurance and the logical feasibility of the project. The notion of water treatment and maintenance for hundreds of years, supported by financial assurance instruments that must also be available for hundreds of years, is difficult to justify.

While the duration of water treatment is unknown, there are many engineered features proposed for this project for which perpetual maintenance is a certainty. These include the water capture and pumpback systems at the flotation tailings basin, the Category 1 stockpile cover system, the hydrometallurgical tailings facility, the overflow control structure at the west pit lake, etc. The FEIS also includes a goal to transition from mechanical water treatment (water treatment plant using reverse osmosis) to non-mechanical methods such as constructed wetlands, permeable reactive barriers, etc. The FEIS does not provide detail on the passive systems, because it states that their effectiveness would have to be demonstrated at a later date. However, it is important to note that passive systems are not maintenance free systems. Available literature

indicates that non-mechanical systems require periodic maintenance and replacement. Therefore, the hypothetical transition to a non-mechanical treatment method does not eliminate the need for perpetual maintenance, in fact perpetual maintenance is guaranteed.

Minnesota Rule 6132.3200, regarding closures and postclosure maintenance of mines, states that the goal of closure and reclamation is that "[t]he mining area shall be closed so that it is stable, free of hazards, minimizes hydrologic impacts, minimizes the release of substances that adversely impact other natural resources, and is maintenance free." Because perpetual maintenance will be required at the hydrometallurgical residue facility, as well as at the numerous engineered features listed above, the project does not appear to meet this goal.

Throughout the FEIS, the co-Lead agencies state that they expect the proposed project to meet all applicable water quality standards. This expectation is based on modeling and GLIFWC does not believe that the modeling is robust enough to support such a statement. However, even assuming that the modeling accurately represents the real future of the project, it is illogical to assume that standards will be met because the modeling assumes effective operation of water capture and treatment facilities in perpetuity. As stated above, the idea that water treatment plants will operate for hundreds of years is not believable. Therefore, the statement that water quality standards will be met is also not believable.

Critical Flaws in Hydrologic Characterization

GLIFWC staff began reviewing the potential environmental impacts of the NorthMet Mine in early 2008. Since the beginning of our review, staff have expressed concerns regarding the hydrologic characterization of groundwater and surface water at the mine site. These concerns have never been fully addressed, which had led to an EIS that inadequately and incorrectly characterizes hydrology at the mine site.

Early in the environmental review, the lead agencies and their contractor (ERM) assumed that the mine site was a "greenfield." This meant that the agencies did not intend to collect baseline water quality data from the Partridge River and Yelp Creek nor did they intend to collect groundwater quality data and groundwater flow information prior to mining. It is now recognized that the mine site has been impacted by the Northshore Mine and is not a greenfield site. But, the co-lead agencies never implemented a robust baseline data collection program to support impact prediction and, compared to other recently proposed mines, NorthMet remains data poor.

The lack of field data means that the NEPA process must rely on models and data interpolations that are not adequate substitutes for site specific data collection. In comments on the DEIS, SDEIS, and PFEIS, GLIFWC staff have repeatedly identified fatal flaws in the XP_SWMM, and MODFLOW models. The co-lead agencies have not been receptive to these comments and have instead relied extensively on materials prepared by Barr Engineering to develop the NEPA document.

The lack of data and lack of understanding of mine site groundwater hydrology is evident in the fatally flawed MODFLOW modeling presented in the FEIS. An adequate characterization of the groundwater system at a proposed mine site is essential to understanding most of the potential impacts from the project. As stated in the GLIFWC letter to the co-lead agencies of August 11, 2015:

> *"The amount of water entering the groundwater system, be it precipitation or discharge from the bed of lakes, rivers or mine pits, determines the direction of flow and dilution of contaminants, and dictates points of compliance for both ground and surface waters. The horizontal and vertical conductivity of the soil and bedrock materials determines how the groundwater system responds to stresses and the rate at which the groundwater flows horizontally and vertically. The character of interaction between surface water features and the groundwater system, whether it is loss of water from rivers or wetlands to the groundwater system, or discharge from the groundwater system to the surface water features, determines predicted impacts to surface water features by stresses such as mine dewatering. Estimating water budgets and quantities of water that must be treated requires an adequate understanding of the groundwater system. None of the above effects of a mine project can be predicted accurately if there is not an adequate characterization of the groundwater system. Without an integrated model of the groundwater system, one would be left with only professional judgment to determine the value of the many interrelated parameters that are used for impact prediction. Professional judgment is useful in checking the reasonableness of the predictions from a groundwater model but, by itself, cannot adequately integrate the complex site specific information, all pieces of which must fit together like a complex puzzle."*

MODFLOW is the primary source of information for defining flowpaths of contaminants from the NorthMet Mine pits at closure. The flowpaths are used to define the area of potential effect for cultural resource impact analysis. The flowpaths and the speed of groundwater flow from the MODFLOW model are critical inputs into the GoldSim water quality model. In fact, without MODFLOW results, the GoldSim model could not be run. Thus the outputs generated by GoldSim that predict ultimate water quality parameters in the Partridge River and property boundary points of compliance are not accurate.

MODFLOW is fatally flawed for one simple reason. It was calibrated to conditions that did not exist at the same point in time. Water levels in the Northshore taconite pits from 1996 were used along with Partridge River baseflows from 1979-1988. In addition, the modeling does not incorporate the predicted Northshore pit elevations at closure which would be significantly lower in elevation than the bottom of the NorthMet pits. This approach is contrary to accepted modeling methodology and constitutes an unacceptable calibration error. These concerns were described in detail in comments on the CPDEIS of 2008 emailed to the lead agencies on February 6th, 2009. It is unclear why the lead agencies have failed to correct an error of this magnitude.

GLIFWC staff have corrected the calibration error in the applicant's model. When corrected, the model indicates that the majority of bedrock groundwater flow from the NorthMet pits and Category 1 stockpile will be to the north toward the Northshore Mine pits and not to the south as described in the FEIS. See GLIFWC letters to the co-lead agencies dated August 11 and December 14th for more information. This 180 degree change in flow direction is significant because it invalidates all mine site water resources conclusions in the FEIS regarding water quality at closure. Furthermore, the water quality effects to Birch Lake and the Boundary Waters of Northshore Mine pit water mixing with NorthMet pit effluent have not been evaluated.

The co-lead agencies now agree that GLIFWC's assessment of the MODFLOW model is correct and that the northward flowpath results when the correct water elevations in the Northshore pits are used. However, the co-lead agencies have adopted an idea developed by the applicant to claim that the north flowpath is unlikely. The idea is that a groundwater mound has/would form in bedrock north of the NorthMet Mine pits and would prevent northward flow of pit water through bedrock at closure. This mound cannot form given the hydrogeologic setting of the area. In fact it is physically impossible for a mound to form. See GLIFWC letter of December 14th for additional detail.

A webinar and teleconference was scheduled by the co-lead agencies on November 17th, 2015 to discuss the inadequacies of the MODFLOW model and the flawed understanding of mine site hydrology presented in the PFEIS. Since that time, the co-lead agencies have refused to discuss this issue with tribal cooperating agencies and intertribal agencies. In an email dated November 30th, 2015 the co-lead agencies communicated that there would be no additional technical engagement with tribal staff on the topic. GLIFWC staff have attempted to engage in this discussion and continue to provide information to the lead agencies. GLIFWC staff have developed the following technical comments letters:

- Dec. 13, 2015. Titled: "Comments on NorthMet FEIS and Section 404 permitting Re: Hypothetical groundwater mound between PolyMet and Peter-Mitchell pits"
- Dec. 14, 2015. Titled: "Comments on NorthMet FEIS and Section 404 permitting Re: Mine site groundwater model calibration."
- Dec. 15, 2015. Titled: "Comments on NorthMet FEIS and Section 404 permitting Re: Likely northward groundwater flowpath of contaminants."

The assessment of hydrologic impacts of the proposed NorthMet mine does not meet the minimum standards of scientific integrity. The co-lead agencies assumed early in the process that bedrock groundwater flow would be to the south at closure. They have since attempted to support their pre-conceived notions about hydrology with information that runs contrary to physical reality. The NEPA process is not well served by this approach.

Cumulative Effects to Tribally Important Resources

The Area of Potential Effect (APE) for groundwater resources presented in the FEIS is inadequate. The groundwater flowpaths at the mine site do not include the bedrock flow to the north, therefore the APE is incomplete. At the plant site, the APE ends at the property boundary north of the tailings basin. While that is the point of compliance for groundwater quality standards, it is not logical to assume impacts would stop at the property boundary.

The NorthMet Project Proposed Action and Land Exchange Proposed Action are both located entirely within the boundaries of the 1854 Ceded Territory. Current, historic, and 'reasonably foreseeable' mining activities have profoundly and, in many cases permanently, degraded vast areas of forests, wetlands, air and water resources, wildlife habitat, cultural sites, and other critical treaty-protected resources within the 1854 Ceded Territory. Lands within the 1854 Ceded Territory that have experienced urban and/or industrial development are permanently 'lost' as a source of treaty resources.

Tribal cooperating agencies consider a 216,300 acre area bounded by the St. Louis River, Lake Superior, Lake Vermilion and the Beaver Bay to Vermilion Trail to be a Tribal Historic District, and the pertinent area for consideration of cumulative effects to cultural resources. Included within the proposed historic district are the headwaters of the St. Louis River, the site of ongoing mineral exploration. The co-lead agencies declined to consider this cultural district as an analysis area in the NEPA process. In addition, tribal cooperating agencies believe the relevant spatial scale for water quality and hydrologic cumulative effects analysis is the entire St. Louis River watershed. Detailed technical support is provided in Appendix C of the FEIS.

GLIFWC staff have noted that elevated specific conductance is a water chemistry 'signature' for mining discharges. The analyses included in Appendix C demonstrates that existing mining discharges result in elevated concentrations of pollutants that persist far downstream in the St. Louis River, which is consistent with the findings of the USEPA in their assessment report on the effects of mountaintop removal and valley fill mining. Given that water quality modeling conducted by the applicant is not scientifically defensible, the co-lead agency contention that water quality impacts from the NorthMet project would not extend to the St. Louis River are not supported.

The Embarrass River, Wyman Creek, Whiteface Reservoir, Stony Creek, West Two River, numerous lakes, and the entire St. Louis River all have mercury-based fish consumption advisories. The FEIS does not accurately account for the impacts of increased mercury loadings on subsistence fishing. Furthermore, increased sulfate concentrations increase methylation rates and bioaccumulation of methylmercury. See Mercury section for additional detail.

The wild rice sulfate water quality standard is exceeded at almost every point where data is available in the Embarrass River watershed and the drinking water standard is exceeded at half of the monitoring locations. In the Partridge River watershed, the wild rice sulfate WQS is

exceeded at fourteen of seventeen locations. The NorthMet Project Proposed Action will contribute additional sulfate to the groundwater from tailings basin water that is not captured and treated, water that seeps through fractures in the mine pit walls once the pit has filled with water, and stockpile infiltration and run-off.

All of the PolyMet predictions regarding discharge from the mine pits and waste rock piles, including the more reactive waste rock piles and the ore surge pile as well as the unlined permanent Category 1 waste rock pile, are made without considering the effects of fractures on discharge to groundwater and surface water. Groundwater contamination from the previous mining activities is still an issue near the LTV tailings basin and mine pits more than twenty years after operations have ceased. The cumulative effects of historic mining are not properly accounted for in the FEIS.

There are 1,387,630 acres of wetlands in the St. Louis River watershed, with 1732 individual wetlands impacted by ditching, totaling 198,989 acres. Approximately 50% of the sub-watersheds have had some degree of impact from ditching, while some have experienced ditching in nearly 100% of their wetlands. These historic impacts are not accounted for in the FEIS. Tens of thousands of acres of high quality wetlands within the St. Louis River watershed have been entirely and permanently lost to historic and current mining operations, many of them prior to regulatory requirements for mitigation. Most mitigation (since it has been required) has taken place outside the St. Louis River watershed and has not replaced the wetland types and functions that have been lost.

The tribal cooperating agencies believe that wind-blown dust particles containing sulfate compounds that are emitted from mining and beneficiation activities could contaminate wetlands, lakes, and streams near the project site and could cause harm to the Species of Special Concern that have been found in this area and to the animals that depend on these plants for food. The cumulative effects of these impacts are not properly characterized in the FEIS.

The tribal cooperating agencies believe it is indefensible to conclude that, amidst a "mining district" with multiple active mine facilities operating in close proximity, that there is no cumulative effect of 24 hour/day, seven days/week of heavy industrial and blasting noise on sensitive wildlife and on traditional cultural practices. See Appendix C of the FEIS for additional detail.

Wild Rice

The information in the FEIS on Wild Rice is inadequate. GLIFWC staff have submitted comments on the deficiencies in wild rice analysis in every previous version of the FEIS yet the issues remain. We are aware of the MPCA determination on waters that are defined as supporting the production of wild rice. We believe that the process used to inform this determination must incorporate historic information of wild rice presence, abundance and habitat. The following section provides historic information on wild rice that, when viewed in combination with other more recent information, suggests that the Embarrass River produces or has produced wild rice in several areas upstream of the current point of compliance. Therefore, we suggest that the compliance point for the wild rice sulfate standard should be upstream of the current location at all areas where rice is growing.

Manoomin or Wild Rice can be found throughout the Great Lakes but the areas of greatest concentration are in Minnesota and Wisconsin (Peter David, GLIFWC wild rice biologist, personal communication, Jenks 1901, Moyle 1944, MRC 1969). The areas of greatest concentration, which are defined as wild rice districts by Jenks, encompass lakes and streams within the region covered by glacial outwash. Jenks' description of the wild rice district is often cited in other publications that describe the range of wild rice (GLIFWC, 1999). Jenks provides additional information on wild rice distribution by stating that within the wild rice district, rice is found wherever there is suitable habitat. Specifically:

"Farther south the St. Louis River system tells the same tale – the streams all bear abundant stores of wild rice" (Jenks, 1901, page 1035)

This publication supports the accounts of tribal members from the tribes acting as cooperating agencies for this project. The draft Cultural Landscape Report prepared as part of the Polymet SDEIS dated September 15, 2011 states, "With the potential for wild rice in the shallow margins of lakes and streams, and abundant wild plant, fishing and hunting habitats, portions of the Preliminary Project APE may have been very attractive to the Ojibwe" (pg. 48). That report also includes an account from a Bois Forte tribal member indicating that harvest occurred on the Embarrass River. Another tribal member stated that she knows of a family that harvested wild rice in the vicinity of the LTV tailings dam on the Embarrass River. These specific descriptions would indicate harvest occurring upstream of Embarrass Lake and upstream of Wynne and Sabin Lakes. This supports the notion of abundant wild rice stands in areas where only smaller stands now remain.

Another corroborating piece of information is the presence of a wild rice farm straddling the Embarrass River. This wild rice farm operated from 1957 until 1993 when the operation went bankrupt (Barr, 1995). Aerial Photos taken in the spring of 1991 and 1992 show the flooded rice paddies and some ditches connecting the farm to the Embarrass River. The use of water from the river in the farm operation clearly defines the Embarrass River as used for the production of wild rice. In addition Unnamed Creek was likely a source of water for the farm. This creek currently

originates at the northwest corner of the LTV tailings basin. According to the Clean Water Act (CWA) this use of water for production of wild rice is a designated use. As such, the sulfate standard applies for the Embarrass River.

Field data collected by Barr Engineering (Barr, 2011) indicates that mine related sulfate effluent has already impacted the river to the point of exceeding the wild rice standard. The Draft Staff Recommendation does not provide information on how the MPCA considered the existing water quality in its recommendation and to what extent the high sulfate values have already impacted wild rice on the Embarrass River. This basic analysis should be part of describing existing conditions in the FEIS. A description of how the issues of wild rice habitat protection and existing elevated sulfate levels in the Embarrass River water were treated in the development of the recommendation is needed. Wild rice in this area is a degraded resource. As such, all remnant populations are in need of protection. This need is further emphasized by the designation of the Embarrass River as impaired in the 2012 draft 303d list.

The current wild rice standard language clearly states that wildlife use of wild rice is an important factor in protecting the plant. It is not clear how MPCA staff determined that the number of wild rice plants upstream of the current point of compliance is not enough to be used as a food source by wildlife. GLIFWC staff is not aware of research that defines the number of plants or the density of a rice bed that would make it usable to blackbirds, muskrat, geese, or other wildlife. A single plant can provide nutrition to wildlife. Furthermore, browsing by wildlife is one of the reasons that wild rice fluctuates in abundance and density from year to year (Peter David, GLIFWC wild rice biologist, personal communication). The variability that is observed in the wild rice survey data on the Embarrass River may well be the result of wildlife use. Finally, Barr Engineering field notes indicate wildlife is using the wild rice stands in the area. These observations of browsing include small stands that are classified in the lowest density and lowest abundance categories (Barr, 2013). This supports the tribal position that all locations where rice is growing should be points of compliance for the 10 mg/l sulfate standard.

Based on available information the GLIFWC staff believes that productive wild rice waters on the Embarrass River are where wild rice is currently growing and is confirmed to have been present in the past. The basis for this view is:

- Wild Rice has been present at these locations during at least one of the five survey years (2009 – 2013).
- The wild rice sulfate standard is 10 mg/l.
- Wild Rice is food for wildlife regardless of its density and the observed inter annual fluctuation in abundance of wild rice in the Embarrass River is consistent with the ecology of wild rice. Barr field notes support this position.
- Historic information from tribal sources indicates past harvest in this area and non-tribal sources support the assertion that this is an area where wild rice was found.
- The existence of a rice farm in this area is consistent with the assertion that the Embarrass River water quality was supportive to wild rice prior to mining impacts.

- Wild rice in the Embarrass River endures despite degraded water quality. It is likely that the degraded water quality has decreased the abundance of wild rice in this river.

Indirect Wetland Impacts

Since 2008, GLIFWC staff have consistently provided information to the co-Lead agencies on methods that could be used to properly characterize indirect impacts to wetlands from hydrologic disruption. This information is based on experience developed in the review of other proposed mines including the proposed Crandon Mine. This is important because the NorthMet FEIS states that the Crandon method is used in the assessment of indirect wetland impacts. Having participated in the development and application of the Crandon method, we can definitively state that the FEIS does not use the Crandon method.

The Crandon method of indirect wetland impact assessment relies on two critical pieces of information; a) a detailed delineation of wetlands leading to accurate wetland classifications, and b) an accurate characterization of groundwater hydrology supported by a calibrated groundwater model.

Uncertainty in Wetland Delineation. At the mine site, the applicant has delineated wetlands that are within the land proposed for exchange with the Superior National Forest. The delineation work has been reviewed and concerns regarding the accuracy of the delineation have been raised. Field work conducted in September of 2010 by staff from the co-lead agencies, tribal cooperating agencies, intertribal agencies and the consultant for the applicant determined that 25% of the wetlands that were visited were incorrectly classified. All of those wetlands were found to have more connectivity with groundwater (more minerotrophic) than the original classification indicated. Furthermore, the field observations did not definitively rule out groundwater connectivity for a number of wetlands (Eggers, 2015). Following the field review, the applicant conducted additional characterization of wetlands using remote sensing techniques (observations from a helicopter). However, these observations are not appropriate to determine groundwater connectivity in wetlands. The co-Lead agencies did not conduct any additional characterization of wetland – groundwater connections. Monitoring sites have been established in a subset of wetlands, but the data is not used in the analysis of indirect impacts.

Lack of a Calibrated Groundwater Model. GLIFWC staff have advocated for the development of a calibrated groundwater model so that the Crandon method could be properly implemented. The co-lead agencies have repeatedly refused to require the applicant to develop a model saying that such a model is too complicated to construct and would not yield useful information. This conclusion is not supportable. Groundwater models are standard requirements of NEPA processes and are routinely developed to provide information on the effects of groundwater drawdown at mines. During the IAP process, tribes, the US Fish and Wildlife Service and technical staff from the MNDNR and MPCA supported the development of a calibrated model. Management from the MNDNR and MPCA later declined to develop the model. The lack of a

calibrated groundwater model was a management decision based on convenience rather than a technical decision based on science.

In lieu of a groundwater model the co-lead agencies decided to use drawdown data from a taconite pit as an analog. This method is flawed for two main reasons. First, the Canisteo pit is located in a different geology and at a different elevation than the NorthMet Mine site. In short, the sites are not analogous. Second, the co-lead agencies used analog data in a selective fashion. They used wells that supported a conclusion that the drawdown in adjacent wetlands would be minor and ignored wells that indicated a substantial effect. To demonstrate this error, GLIFWC conducted an independent indirect wetland analysis for the NorthMet Mine site (Attachment A). The analog data in this analysis was provided by the former MNDNR Mining Hydrologist and ignored by the co-lead agencies. The GLIFWC analysis also used the Crandon method to determine the susceptibility of different wetland types to groundwater drawdown. We submit that the GLIFWC analysis is more defensible from a scientific point of view than the analysis in the FEIS because it uses all available data to establish impact zones and properly assigns impact values based on the Crandon method.

One important difference in the analysis of the co-lead agencies and the analysis done by GLIFWC is in the assumption of impacts to ombotrophic and minerotrophic bogs. The co-lead agency analysis assumes that there is a low risk of drawdown impacts to ombotrophic bogs while the GLIFWC analysis assumes that impacts are more likely. The Crandon method did not make the assumption that ombotrophic wetlands have a low risk of impact. It relied on the groundwater model to determine the stress on a wetland and then used the wetland classification to characterize the potential impact.

The GLIFWC position is supported by literature and expert analysis. Whittington and Price (2013) describe drawdown impacts to peat bogs in the James Bay lowland of northern Ontario. Dr. Paul Glaser, a recognized authority on peatlands, indicated in his 2014 comments on the SDEIS that "Even if ombotrophic raised bogs are present within the study area, they may still be hydraulically connected to groundwater flow systems and sensitive to impacts from mine development unless they support perched water table mounds (i.e. perched recharge mounds)." Dr. Glaser goes on to say that "no convincing evidence is provided to support their presence." Finally, even if raised bogs occur at the site, there are a number of publications that report direct connections to groundwater flow systems in the underlying mineral sediments (Siegel and Glaser 1987; Siegel, et al., 1995; Glaser et al., 1990; 1997; 2004ab; 2006). Dr. Glaser states that "[t]hese publications demonstrate that peatland development is dominated by the hydrogeologic setting and not by surface processes." This conclusion supports GLIFWC's analysis assumption that wetlands labeled ombotrophic by the co-lead agencies may indeed be impacted by drawdown.

Additional support for Dr. Glaser's conclusions and for the GLIFWC independent wetland analysis is found in the co-lead agency response to public comments on distinguishing between ombotrophic and minerotrophic bogs (Eggers 2015). This document states that "all wetland types within this zone would experience some degree of hydrologic effects due to

groundwater drawdown" and supports GLIFWC's analysis by stating that "the potential for indirect impacts to all bog communities within the 0 to 1000 foot analog zone is acknowledged."

In conclusion, the analysis of indirect wetland impacts in the FEIS is not adequate. It relies on questionable wetland classifications, includes a flawed understanding and implementation of the Crandon method, uses a selective subset of available data, and includes a flawed understanding of the connection between bog wetlands and groundwater flow systems.

Inadequate Wetland Mitigation Requirements

The proposed mitigation plan is inadequate. The vast majority of mitigation and/or restoration credits to come from outside the Partridge, Embarrass, and St. Louis River watersheds. There is no justifiable reason to permit out-of-watershed mitigation when in-watershed opportunities still exist, especially when the St. Louis River watershed as a whole has experienced cumulative wetland destruction, degradation and hydrologic alterations in well over 50% of the watershed.

There is a defined hierarchy for determining the appropriate type and location of wetland mitigation:

1. Credits at a mitigation bank
2. In-lieu fee program credits
3. Permittee-responsible mitigation using a watershed approach
4. Permittee-responsible mitigation through on-site- and in-kind mitigation
5. Permittee-responsible mitigation through off-site and/or out-of-kind mitigation

The 2008 Federal Mitigation Rule also states that mitigation sites should be located in within the same watershed as the impact site, and where they are most likely to successfully replace lost functions and services. The Corps is required to "use a watershed approach to establish compensatory mitigation in their permits to the extent appropriate and practicable." In fact, adhering to the watershed approach in approving compensatory mitigation sites is the *only* exception to the requirement for in-kind mitigation (§332.3(e)(2)).

Although the Corps has some discretion in establishing compensatory mitigation, it must systematically consider options in the prescribed order. And although out-of-watershed mitigation can be permitted, its appropriateness is usually considered at the scale of either 8-digit or 6-digit Hydrologic Unit Codes (HUCs). In the case of the NorthMet Proposed Project, PolyMet is proposing that two-thirds of its mitigation will occur outside the major continental drainage divide (see map in Attachmant C), within a different 2-digit HUC scale, and based upon the lowest tier of compensatory mitigation types in the hierarchy.

The potentially impacted wetlands have been recognized as Aquatic Resources of National Importance (ARNI). These wetlands have high functional values and 92% of them are of high overall quality. Finally, the entire mine site area has been characterized as an area of high biodiversity significance. Given the ecological value of the mine sites wetlands and habitat, the proposed mitigation ratios and mitigation sites are inadequate.

Seepage Capture Efficiency

As detailed in comments submitted to the lead agencies for the 2009 DEIS, the 2014 SDEIS, and the 2015 PFEIS, the water quantity and quality analyses for the Partridge and Embarrass Rivers are inadequate. The results, be they deterministic (DEIS) or in the form of probability distributions (SDEIS), are based on a flawed understanding of hydrology at both mine site and plant site. This flawed understanding, reflected most prominently in the errors in the MODFLOW hydrologic modeling, are carried forward to the GoldSim water quality modeling. The co-lead agencies appear to disregard these problems because there is faith that the seepage capture and treatment systems will work at over 90% effectiveness for centuries. The FEIS claims of long term compliance with applicable water quality standards depend entirely on this leap of faith. On conference calls scheduled to discuss these issues, the lead agency consultants have stated that the effectiveness of the capture systems have not been questioned and the lead agencies have not been able to provide any references that would support their position. We suggest that there are substantial reasons for skepticism regarding capture efficiency for the flotation tailings basin, hydrometallurgical tailings basin, and Category 1 stockpile seepage capture systems. This skepticism is based on available literature and the performance of other facilities in the immediate vicinity.

The EPA has conducted an analysis of the effectiveness of seepage capture systems (EPA, 1998). This analysis looked at capture systems at 36 facilities and evaluated their effectiveness based on the performance requirements at each site. It is difficult to extrapolate the results of this analysis to the PolyMet setting because a) the required effectiveness varied from facility to facility; b) the way in which effectiveness was measured was different (i.e. water quality improvements downstream versus change in hydrologic head pressure); and c) data collection varied between facilities. Despite these difficulties, the report indicates that 10% of the reviewed containment systems failed to meet the desired performance objectives and required corrective action. An additional 19% of the evaluated facilities did not have sufficient data to conclude whether the containment system was operating successfully or not. Furthermore, there is no information on the effectiveness of any of these facilities at timeframes remotely comparable to the needs at NorthMet. In the EPA report, long term is considered 30 years whereas the water capture needs at NorthMet are likely perpetual for the flotation tailings basin, Category 1 stockpile and hydrometallurgical tailings basin. Finally, none of the facilities in the study are as large as the one proposed by PolyMet.

At the tailings basin, PolyMet has proposed to install a seepage collection system around the north, east, and west sides of the facility. The scale of this engineering control is extensive. It

would be approximately 5 miles long and would have to be keyed to bedrock that is 25 to 50 feet below ground surface. The most likely pathway for leakage at this barrier will be in the vicinity of the key with bedrock (EPA, 1998). This feature and the similar containment system at the Category 1 waste rock stockpile are assumed to capture 93% of water leaving the facilities for an indeterminate period of time. As previously stated, there is no scientific justification for this number. The only examples we are able to identify at this time suggest capture rates that are lower.

In the Iron Range, GLIFWC staff are aware of two examples that are directly analogous to the proposed PolyMet containment system. These are the seepage collection system at SD026 on the LTV basin itself, and the seepage collection system at the MINTAC tailings basin.

SD026. The system is supposed to capture 100% of water leaving the tailings basin and entering Second Creek. The FEIS acknowledges that this water capture system is not operating as effectively as anticipated. Adaptive management is being proposed to augment the effectiveness of the system but no specific methods are identified.

MINNTAC. The MINNTAC tailings basin is of similar age and design as the LTV tailings basin that PolyMet proposes to use. Both are large, unlined facilities that are designed to allow water seepage to surface and groundwater in order to maintain structural stability. Both facilities have been discharging thousands of gallons per minute of high sulfate wastewater into the environment for decades. MINNTAC, as part of a schedule of compliance, has begun constructing a seepage capture system that is intended to bring the facility into compliance with applicable water quality standards. The capture system is similar to the one proposed by PolyMet in that it consists of a trench to capture seepage and a system that would pump tailings water back into the facility. The MINNTAC system was originally intended to extend to bedrock but that extension was not possible in some locations because of the presence of large boulders that made construction difficult. Because the geology of the surficial deposits is similar at the LTV facility, it is likely that similar difficulties will be encountered by PolyMet that would decrease capture efficiency. It is important to note that seepage capture of greater than 95% is needed at MINNTAC in order to achieve compliance with applicable water quality standards. However, this high capture efficiency was not considered feasible and MINNTAC predicted that their capture efficiencies would not exceed 60% (US Steel Corp., 2007). Actual performance of the capture system is below 50%. Ultimately, the main purpose of the system is to comply with water quality standards. The capture system will not be able to achieve that goal. Because MINNTAC is the only facility that is analogous to the LTV basin, there are serious doubts about the predicted 90% or greater capture efficiency used in the PolyMet FEIS.

The prediction of water quality standard compliance for this proposed project hinges on the perfect operation of the water capture systems. The reliance on this engineered containment system that uses overly optimistic capture rates and must function in perpetuity is not scientifically supported and therefore is not appropriate for the FEIS.

Mercury

The assessment of mercury and methylmercury impacts that would result from the proposed NorthMet project is not adequate. Cooperating tribes and intertribal agencies have raised mercury and methylmercury as concerns since the pre-draft environmental impact statement review of 2008. Methylmercury is a bioaccumulative neurotoxin that disproportionately impacts tribal populations that depend on fish for a subsistence diet. While the FEIS mentions this issue, the co-lead agencies have refused requests to properly characterize the additional influx of methylmercury to the St. Louis River as a result of wetland and saturated overburden excavations at the mine site. Predicted mercury loadings as a result of the NorthMet Project continue to constitute a Major Difference of Opinion (MDO) between the Co-lead and Tribal Cooperating Agencies. Again, the co-lead agencies have not been receptive to tribal input and thus the issue remains.

The FEIS states that, based on mercury mass balance analyses, the NorthMet Project would result in a net increase in mercury loadings to the Embarrass River of 0.2 g/year (from 22.3 to 22.5 g/year), which would be offset by a 1.2 g/year net decrease in mercury loadings to the Partridge River (from 24.2 to 23.0 g/year), resulting in a combined overall decrease in mercury loading to the St. Louis River of 1.0 g/year.

We disagree with the treatment of mercury in the FEIS and the resulting conclusions in three fundamental ways. In contrast to what is laid out in the FEIS, it is our expert opinion that:

I. Increased mercury loadings to the Embarrass River may not be permittable. A net decrease in mercury loadings to the St. Louis River does not justify or make acceptable the increased mercury loadings to Embarrass River.

II. The mass balance analyses that lead to the conclusion that mercury loadings will not increase in the St. Louis River are flawed in numerous ways. Mercury loadings to the St. Louis River are in fact likely to increase as a result of the NorthMet Project.

III. While mercury loadings to the Partridge, Embarrass, and St. Louis Rivers are discussed, there is no adequate consideration of the fact that more of the mercury entering these systems will be in the form of methyl, rather than inorganic, mercury. This has the potential to greatly impact fish tissue mercury in these systems and the subsequent risk to fish consumers, both human and wildlife.

Each of these three points is explained, in brief, below.

I. Increased Mercury Loadings to the Embarrass River are not Legally Permittable. The Embarrass River flows through a chain of lakes including Wynn, Sabin, Embarrass, and Esquagama Lakes. Each of these lakes are on the 303(d) Impaired Waters List for mercury in fish tissue. In addition, Wynn and Sabin Lakes are on the proposed 2014 303(d) Impaired Waters list for mercury in the water column. According to the U.S. 9th Circuit Court of Appeals in the case of *Friends of Pinto Creek vs. the U.S. EPA* ("The Carlota Decision"), a new discharge that would further degrade waters with existing water quality impairments cannot be permitted. The

decision further clarified that the Clean Water Act ("CWA") does not have a provision that allows for "trades" in which increased pollutant discharges to one waterbody can be offset by decreases to another. Therefore it appears that under the CWA, a new source such as the NorthMet Project cannot discharge additional mercury to these mercury impaired waters. According to the FEIS, the NorthMet project would increase mercury loadings to the Embarrass River (which includes the lakes through which it passes) by 0.2 g/year (from 22.3 to 22.5 g/year). This does not appear, based on the Carlota Decision, to be permittable. Similarly, based on the Carlota Decision, it does not appear that the additional loading can be offset by decreases in mercury loadings to the Partridge River, as argued in the FEIS.

According to federal regulations [40 CFR 1502.16 (c)], a proposed action's EIS must include a discussion of "possible conflicts between the proposed action and the objectives of federal, regional, state, and local land use plans, policies and controls for the area concerned." It is further stated in 40 CFR 1506.2 (d) that "to better integrate environmental impact statements into state or local planning processes, statements shall discuss any inconsistency of a proposed action with any approved state or local plan and laws (whether or not federally sanctioned). Where an inconsistency exists, the statement should describe the extent to which the agency would reconcile its proposed action with the plan or law." One such program with which the NorthMet Project is inconsistent is the Lake Superior Binational Program's Zero Discharge Demonstration Program (ZDDP), as described in the Lake Superior Lakewide Management Plan (LaMP).

The ZDDP established Lake Superior as a demonstration project to achieve zero discharge and zero emission of nine toxic, persistent, and bioaccumulative chemicals, including mercury, from within the Lake Superior basin by 2020. The LaMP Critical Contaminants Goal further states that "levels of persistent, bioaccumulative, and toxic chemicals should not impair beneficial uses of the natural resources of the Lake Superior basin." The FEIS only mentions the ZDDP and the LaMP once, and only in Appendix A (A-405, Theme MERC 01; A-464 Theme PERM 27) in response to previous concerns raised about the failure to discuss the Project's inconsistencies with these programs. The MERC 01 Thematic Response describes the ZDDP, but in no way discusses how the Project would address the fact that increased mercury loadings to the Embarrass River are in direct violation of the objectives of the ZDDP. Theme PERM 27 raises the concern that the Project is inconsistent with the LaMP, but the Thematic Response states only that, if permitted, the Project would be required to comply with applicable laws and regulations. There is no attempt in the FEIS to reconcile the proposed action with the objectives of LaMP and the ZDDP, as is required for an EIS under 40 CFR 1502.16 (c) and 40 CFR 1506.2 (d).

All surface waters within the Lake Superior basin, including all NorthMet Project area waters, are designated Outstanding International Resource Waters (OIRW) under Minnesota (MN) Administrative Rule 7050.0470. MN Rules 7052.0300 and 7052.0350 prohibit any new or expanded point source discharges of bioaccumulative substances of immediate concern (BSIC), including mercury, to any OIRW. Thus, under MN law, as under the federal law as described

above, increased mercury loadings to the Embarrass River, or any other likely affected surface waters, do not appear to be permittable.

All waters likely to be impacted by the NorthMet Project lie within the 1854 ceded territories. Several Chippewa tribes retain the right to hunt, fish, and gather throughout this territory, according to the 1854 Treaty of LaPointe. The federal government has a trust responsibility to the Bands to maintain these treaty resources. The fact that the NorthMet Project would increase mercury loadings to the Embarrass River and the chain of lakes through which it flows (Wynn Lake, Sabin Lake, Embarrass Lake), which are already listed on the 303(d) Impaired Waters list for mercury in fish tissue, represents an adverse impact to a critical trust resource and should not be permitted. Treaty fishing rights cannot be fully exercised when mercury contamination causes fish consumption to be restricted to protect human health.

II. Mercury Loadings to the St. Louis River are Likely to Increase as a Result of the NorthMet Project. The FEIS predicts that there will be a small decrease in mercury loadings to the Partridge River and thus an overall net decrease in mercury loadings to the St. Louis River, despite increased mercury loadings to the Embarrass River. In addition to the fact that a "tradeoff" between increased mercury loadings in the Embarrass River and decreased loadings in the Partridge River does not appear to be permittable (as described in Part I, above), critical flaws in the analysis of mercury in the FEIS have led to incorrect conclusions about mercury loadings from the NorthMet Project. It is likely the Project will actually result in a net increase in mercury loadings to the St. Louis River.

Numerous critiques of the mercury mass balance analyses were submitted by GLIFWC staff and others as comments on the Project's SDEIS and PFEIS. None of these concerns were addressed in the FEIS. Therefore, rather than detail each issue here, the main points are summarized.

1. The mass balance is based on flow estimates from flawed hydrologic models. A mass balance, by definition, relies on accurate estimations of concentration and flow. As a result, the accuracy of the predicted mercury loadings from the mass balance analyses is unreliable. See the hydrologic section for detail of the hydrology modeling issues that have been identified.
2. The mass balance at the plant site is dependent upon the assumption that the NorthMet tailings will adsorb mercury in a similar capacity as the existing LTVSMC tailings. This assumption is based on a 2006 bench top study conducted by Northeast Technical Services, Inc. (NTS). Study details can be found in Appendix B of FEIS reference "Barr 2007d." This study is insufficient to predict the magnitude of mercury adsorption by the NorthMet tailings. The flask test was conducted over only an 8 hour period to model a centuries long process. There was only one sample with no replication and no attempt to mimic in situ conditions. Further, the study results were incorrectly interpreted, stating that after rapid initial adsorption, mercury levels remained stable throughout the

experiment. In reality, the mercury concentrations in the water nearly doubled between hours 4 and 8, when the experiment was terminated, increasing from <0.5 to 0.9 ng/L. If this trend continued, the water would exceed the 1.3 ng/L GLI standard for mercury by hour 12.

3. A superior test of the ability of NorthMet tailings to adsorb mercury was also performed by NTS, but was not discussed in the FEIS. Details can be found in the FEIS reference "SRK 2007b" (see discussion of mercury on page 82 of the reference). In contrast to the 8 hour bench top study, the results indicated that precipitation coming into contact with Duluth Complex rock decreased from 12 to 1.9-3.6 ng/L over 32 days, suggesting while the tailing may have some capacity to adsorb mercury, the tailings basin water is still unlikely to meet the 1.3ng/L GLI standard.
4. The mass balance at the plant site is dependent upon the assumption that the existing LTVSMC tailings will continue to adsorb mercury in perpetuity. But, adsorption sites can saturate after sufficient exposure to mercury containing waters, allowing the mercury to flow through the system unimpeded. In addition, the adsorption sites can be unstable as a result of environmental conditions such as changes in pH, resulting in the release of previously adsorbed mercury. In fact, there is already existing seepage from the LTVSMC tailings exceeding the 1.3ng/L GLI standard, as shown in Table 4.2.2-35 of the FEIS.
5. The mine site mass balance does not account for seepage from the saturated overburden at the OSLA. This material contains sequestered mercury from past deposition. This is a particular concern for the peat overburden, as peat is known to be particularly efficient at sequestering mercury. There is no estimate of the amount of mercury in these materials or their propensity to release mercury when water moves through them.
6. The mine site mass balance and estimates of mercury concentrations in the West Pit are supported by data presented in the FEIS for analog lakes. The data (FEIS Table 5.2.2-48) shows average mercury concentrations of 0.66 and 0.97 ng/L for analog natural seepage lakes and pit lakes, respectively. The more detailed source data for this summary table can be seen in Section 6.6 of the FEIS reference "PolyMet 2015m." At least 6 of the 26 analog lakes had individual samples over the GLI standard of 1.3ng/L, and two lakes had average concentrations above 1.3ng/L. Further, data collected by the Fond du Lac Band [available upon request] on total mercury in concentrations in seepage lakes on or near the Fond du Lac reservation between 2011 and 2014 suggest that levels may be much higher in analog natural seepage lakes closer to the proposed Project, than those presented in the FEIS which were further away in Voyagers National Park and sampled over a decade ago. For the 27 lakes sampled by the Fond du Lac Band, 22 had individual samples over the 1.3ng/L GLI standard, and 20 had mean concentrations exceeding 1.3ng/L. Of the 59 samples collected and analyzed from these lakes, 36 (61%) exceeded 1.3ng/L. This suggests that the analog lakes chosen for analysis in the FEIS are not representative of area lakes and underestimate the predicted West Pit mercury

concentration. It is likely that the mercury concentration in the West Pit will exceed the GLI standard.

7. The mass balance analyses do not include mercury from air deposition, which has been quantified but is only treated independently. Appropriately accounting for the mercury reaching the Partridge and Embarrass River watersheds as a result of air deposition would increase the estimated mercury loadings to these systems calculated in the mass balance analyses.
8. There is little confidence in the predicted tailings basin seepage capture rates, causing this mercury source to be underestimated. Predicted compliance with water quality standards is entirely dependent on the assumption that >90% of the seepage will be captured. The seepage capture efficiencies assumed in the FEIS are overly optimistic considering that the seepage capture systems at the MINNTAC tailings basin and the southern toe of the LTV basin have not been able to achieve these high efficiency rates. Any water that is not captured by the proposed capture systems that enters the waters of the U.S. is subject to NPDES permitting.
9. The FEIS further states that the mass balance estimates are conservative because waters will be further treated by reverse osmosis (RO) to remove additional mercury. According to FEIS reference "Barr 2013f", mercury capture rates by RO are known to be as low as 22%. Further, the capture rate is highly dependent on the form of mercury, with only particulate mercury generally being captured. Capture efficiency for free mercury is much lower. The only available data for methylmercury shows that RO is not capable of removing methylmercury. The lack of data demonstrating the ability of a RO system to adequately remove mercury from captured water is inappropriately compensated for in the FEIS by a number of proposed adaptive management strategies for the RO system should it prove inadequate.

In addition, a mass balance approach is not the most appropriate mechanism for predicting mercury loadings to the Partridge and Embarrass Rivers, and ultimately the St. Louis River. The FEIS did not include mercury in the GoldSim model as it did for other models, citing an insufficient data and a lack of understanding of mercury dynamics. No reasonable attempt was made to model the impacts of mercury due to the NorthMet Project, even though other applicable models exist and should have been implemented. The adherence of the Project to applicable mercury water quality standards cannot be adequately determined without such modeling data.

III. Increases in the Relative Amount of Methylmercury Will Impact Fish Tissue Mercury. Due to the likely increase in mercury methylation, as described below, the NorthMet Project has the potential to increase fish tissue mercury in the St. Louis River watershed, which lies within the 1854 ceded territory where a number of Chippewa Bands exercise treaty fishing rights. Increases to fish tissue mercury, for which these waters are already impaired, impact the treaty rights of the Bands to harvest fish. Treaty-reserved rights cannot be fully exercised when fish consumption must be restricted to protect human health. Any increase in mercury bioavailability to the

Partridge, Embarrass, or St. Louis River watersheds constitutes a significant adverse impact to a critical trust resource.

GLIFWC staff believes that total mercury loading to the St. Louis River is likely to increase as a result of the NorthMet Project, as described in Part II, above. In addition, we assert that the FEIS is deficient in its characterization of methylmercury. The methylmercury data presented in surface and groundwater is insufficient to describe the current conditions and methylating environment. As a result, the potential impacts the Project is likely to have on mercury methylation, such as from changes in sulfate concentrations, hydrology, and water quality are not easily assessed. It is our expert opinion that the Project will result in a higher percentage of mercury in the form of methylmercury in receiving and downstream waters which will result in increased mercury entering the aquatic food web and ultimately higher fish tissue mercury. If a higher percentage of total mercury is released in the form of methylmercury, changes in fish tissue mercury are not directly proportional to changes in total mercury loads, as stated in the FEIS.

The WWTP design, which utilizes reverse osmosis, is not only inefficient at removing non-particulate inorganic mercury, it is not capable of removing any methylmercury, as stated in the FEIS reference "Barr 2013f". This is of particular concern because the seepage capture system isolates a portion of existing wetlands between the capture system and the basin that will receive most of the mercury coming from the tailings basin. Wetlands provide a prime mercury methylating environment. In addition, the groundwater at the toe of the tailings basin is predicted to be very high in sulfate, which will further accelerate mercury methylation. The result will be a much greater proportion of the mercury entering the WWTP being in the form of methylmercury than is found in the current environment. Since there is no technology in place to remove this methylmercury, it will be discharged to the Embarrass River increasing fish tissue mercury in downstream waters, including the St. Louis River.

The FEIS limits its analysis of methylmercury to simple proportionality to total mercury, without considering other factors that affect mercury methylation, incorrectly claiming that the factors and mechanisms affecting methylation are poorly understood. In fact, many factors affecting mercury methylation are known (e.g. sulfate concentration, type and activity of methylating bacteria, pH, organic matter, dissolved oxygen, etc.) and models exist for predicting mercury methylation.

Ombrotrophic bogs, which are peat-dominated, primarily rain-fed, and acidic, are extremely efficient mercury methylating environments. This methylation can be further enhanced by the addition of sulfate containing runoff. The FEIS does not present a consistent model for mine site hydrology. For many years the lead agencies have maintained that these peatland bogs are "perched" and therefore independent from any mercury and sulfate impacts on receiving waters (See GLIFWC comments on indirect wetland impacts above). In contrast to this position, the FEIS states that water can move from the surficial aquifer (where the wetlands are) to bedrock in a dewatering situation (FEIS page 5-111). These conflicting conceptual models of

mine site groundwater hydrology are mutually exclusive. For mercury and methylmercury related conclusions to be defensible, a consistent model of the mine site hydrology must be developed. Any wetlands that have at least a partial connection to the groundwater should be considered a potential source of methylmercury. Enhanced vertical hydraulic gradients resulting from mine pit dewatering could result in significant interactions between the bogs and groundwater, even dewatering wetlands that may be entirely surface water dependent under normal conditions. If groundwater under these wetlands were to be drawn down, the wetlands would be impacted and there would be a likely dewatering of peat deposits. This cycle of wetland dewatering and rewetting is known to enhance mercury methylation. The resulting effect on methylmercury production and release, and ultimately on fish tissue mercury, have not been adequately evaluated in the FEIS.

Characterization of Impacts along the Rail Corridor

The assessment of environmental impacts resulting from spillage of ore fines along the rail corridor is inadequate. The FEIS acknowledges that PolyMet would use old side-dump rail cars and states that they would be refurbished. This refurbishment merely involves tightening screws and hinges and would do absolutely nothing to reduce the escape of ore fines. These dust sized particles of ore are highly reactive and would escape through hinges and openings on the rail cars. Given the duration of this proposed project and the large quantity of materials to be moved, approximately 228 million tons of ore and 394 million tons of waste rock, there will be tracking, dusting, and spillage of material that has been demonstrated to leach contaminants when exposed to air and water. Even a loss of only one thousandth of one percent (0.001%) of the extracted material to tracking, dusting or spillage would result in 6,220 tons of fine leachable material being released into the environment. Our experience with a much smaller, shorter duration, sulfide mine in Wisconsin (Flambeau Mine) indicates that tracking and dusting of ore and waste rock, even at a level that is unnoticed during operations, can result in soil and runoff contamination that exceeds standards.

The FEIS states that dust deposition would occur within the first 1000 meters of the rail corridor. There is no scientific basis for this conclusion. This number is taken directly from a document prepared by the applicant and does not have support in literature. The FEIS does reference a preliminary geochemical model that is detailed in the Waste Characterization Data Package. This analysis assumes that ore dust is deposited evenly along the rail corridor, reports that water quality standards would be exceeded for Copper, Nickel, Aluminum and Cobalt. There are no mitigation strategies offered for this impact other that dilution from rainwater.

During the NEPA process, a number of alternatives were proposed to eliminate the deposition of ore dust along the rail corridor. One of these alternatives included sealing the gaps in the rail cars and another was the purchase of new rail cars that would be completely sealed. GLIFWC staff have advocated for the purchase of new rail cars to eliminate the possibility of dust spills along the rail line. However, the FEIS is only describing a tightening of hinges which would be completely ineffective. The permit to mine must include a permit condition requiring

PolyMet to purchase sealed rail cars for ore transport. This is the only method for preventing releases of ore dust and violation of water quality standards.

Underground Mining and West Pit Backfill Alternatives

GLIFWC staff believes that the underground mine and west pit backfill alternatives were prematurely eliminated from consideration for the NorthMet project. We believe that there is potential for significant environmental benefits to these alternatives when compared to the proposed action. The discussion in the FEIS is inadequate because cost is ultimately the reason for exclusion of these alternatives. Furthermore, the co-lead agencies have not conducted independent investigations into the feasibility of the alternatives. Rather the lead agencies took the technical response memo presented by the applicant and adopted it as their own.

Underground Mine Alternative. The Underground Mining Alternative Assessment for the NorthMet Mining Project and Land Exchange Environmental Impact Statement document dated February 5th 2013 provides the lead agency rationale for eliminating the alternative from further analysis in the FEIS. The document states that for an alternative to be evaluated it must meet 5 screening criteria:

1. be technically feasible
2. be available
3. offer significant environmental benefits over the proposed project
4. meet the purpose and need
5. be economically feasible

The co-lead agency position paper correctly states that the underground alternative would offer significant environmental benefits over the proposed action. In some areas these benefits would be substantial. The roughly 1000 acre wetland fill could be almost completely eliminated and the amount of tailings and waste rock generated by the project would be significantly reduced. The water quality and quantity impacts on surface and groundwater would be mitigated. This is particularly important given the probability that the NorthMet project is likely to violate water quality standards and the certainty that the project would require perpetual water treatment. In addition to the environmental benefits the document correctly states that underground mining is technically feasible and available at the site. It is important to note that with underground mining the land exchange with the Superior National Forest would not be needed therefore environmentally sensitive areas like the 100 mile swamp and essential lynx habitat would remain in the federal estate.

The only rationale that is used to eliminate the alternative is economic feasibility. However, no detailed economic information is provided to support that claim. All other objectives of the purpose and need statements in section 1.3.2.1 of the FEIS are met. Therefore, the question on further analysis is determined by the applicants' assessment of the economics of

the alternative. In addition, no information on the economic benefits of an underground mining alternative are mentioned. These benefits include:

- An underground mine would not require a land exchange with the United States Forest Service.
- Economic benefits (environmental goods and services) provided by wetlands that would not be excavated (see ecosystem valuation section).
- Economic impact of perpetual maintenance and water treatment at the site. Of note, there is no discussion on the cost of wetland mitigation activities that are needed with an open pit mine. An underground mine would not require extensive wetlands mitigation costs for wooded swamp and bog sites that could reach between $35,460,000-$110,205,000 (i.e. 1200 acres x 1.5 rate x $19,700/acre ACOE source and 1200 acres x 1.5 rate x $61,225/acre MN Department of Transportation – (Environmental Law Institute, 2007 and US ACOE, 2010).

The Underground Mining Alternative Assessment relied heavily on an InfoMine model to determine economic feasibility. However there is no detail on the model itself, the model assumptions or how the model calculates its results. For a complete evaluation of the alternative, a review of this model should have been done by the co-lead agencies.

Finally, it appears likely that the project as proposed is likely to violate applicable water quality standards. This means that the current proposal is not likely to be permitted. Furthermore, underground mining would not result in excavation of overburden and would not result in mercury and methylmercury emissions at the mine site. Because of this, it seems reasonable that an underground alternative be considered as an additional mitigation measure.

West Pit Backfill Alternative. Based on the lead agency memorandum titled Co-lead Agencies' Consideration of a West Pit Backfill Alternative dated April 11, 2013 it is clear that this alternative meets the purpose and need, is available, is technically feasible, and is economically feasible. The document argues that environmental benefits are unclear. However, because of the screening level analysis used by the co-lead agencies the full effect of the alternative on the environment is not known. Page 3 indicates that there is no information to determine water quality projections under this alternative. Therefore the primary potential benefit of this alternative is not addressed. Until this information is developed, GLIFWC staff maintain that backfill of the west pit may provide long term water quality benefits. Given that the current project is likely to violate water quality standards, additional mitigation is needed and this alternative should be more fully analyzed.

The proposed NorthMet project proposes to mine a relatively small portion of the ore body. Figure 3.2-10 of the FEIS indicates that an upper mineralization zone and a portion of the Unit 1 mineralization are the targets. This mine plan appears to leave behind a substantial portion of ore. GLIFWC staff has argued that the remaining ore could be accessed through underground mining methods. According to the co-lead Agencies' document "Consideration of a West Pit

Backfill Alternative" dated April 11, 2013, a major reason for the development of an open pit mine plan is that there is a lease agreement between PolyMet and the owners of mineral rights immediately southwest of the toe of NorthMet's west pit. These private lease agreements apparently include using the west pit as a portal for future mining activities. In addition, tribal cooperating agencies have provided the lead agencies with PowerPoint presentations from PolyMet staff to their investors that tout the potential for future mining of these mineral resources southwest of the west pit.

If the west pit is to be used as a portal for this future mining, then that should be described in the FEIS and the environmental consequences assessed. The Evaluation of Backfilling the NorthMet West Pit (December 2012) states on page 2 "mineralization on the western end is much more flat laying, dipping at about 15 degrees and could be developed in the future via expansion of the proposed open pit mining operation and/or underground mining from the base of the west pit." It appears that the FEIS is describing a project that is not complete in that future mining is not included. What are the implications of developing an underground mine that extends from the west pit to surface and groundwater resources of the Partridge River watershed?

Another stated reason for avoiding backfill for the west pit is the lease requirement of not encumbering the mineral resources to the southwest. The assertion that backfilling the west pit would encumber minerals is ludicrous. We disagree with the notion that the only way to access minerals at depth is through the bottom of the west pit. These minerals could be accessed through other standard underground mining techniques from other locations. In fact, these minerals are accessible now and would continue to be accessible even if the NorthMet project is never built. Taking advantage of an existing pit may provide economic benefits to a mining company but it is unclear why a regulatory agency would prefer this method without first conducting an analysis. If the co-lead agencies are taking the position that the preferred alternative of a future underground project includes a portal through the west pit, then they need to provide a scientifically defensible reason for that decision.

Finally, the co-lead Agencies' Consideration of a West Pit Backfill Alternative dated April 11, 2013 provides several reasons for the conclusion that backfill would not provide significant environmental and socioeconomic improvements over the proposed action. Page 3 of the document clearly states that there has been no analysis done to support these conclusions.

It appears that economic considerations of a future mine expansion are the only concrete reasons for not conducting an analysis of the environmental and socioeconomic benefits of backfilling the west pit. The NorthMet project as proposed is a perpetual maintenance and water treatment facility. It seems logical that every available option that might improve the long term impacts of the project should be explored regardless of the commitments that applicant may have made on their mineral lease. GLIFWC staff suggests that this alternative has been eliminated prematurely and that a full analysis is needed.

Socioeconomics

The discussion of socioeconomic effects of the proposed NorthMet project is inadequate. The IMPLAN model is the primary tool for assessing the economic benefits of the proposed project. However, IMPLAN cannot calculate the negative effects of a mine project on other areas of the economy that depend on unspoiled and healthy natural environments (tourism, hunting, etc.). In addition, IMPLAN cannot assess the economic impact of the proposed project on ecosystem goods and services that nature provides to society. An example of these ecosystem goods and services is free water treatment and flood controls provided by wetlands. If the NorthMet project is permitted, thousands of acres of wetlands will be destroyed and their water treatment functions will have to be replaced by a constructed treatment plant costing millions of dollars a year to operate. Recently, an ecosystem services valuation has been completed for the St. Louis River watershed (Attachment B). This document provides many of the data and tools needed to properly assess the effects of the proposed project on the goods and services that the area provides. Tribal cooperating agencies and intertribal agencies asked the co-lead agencies to include the ecosystem valuation information in the FEIS. This request was declined.

GLIFWC staff used the information in the Ecosystem Valuation Report for the St. Louis River watershed to characterize the losses in ecosystem services to the watershed as a result of the land exchange and the NorthMet Mine. The analysis of direct impacts includes wetlands filled at both the mine and plant sites. The analysis of indirect wetland impact focuses on the mine site of the proposed project which is the area of the proposed land exchange and does not include indirect wetland impacts at the plant site (Attachment C). This is one of the possible applications of the ecosystem valuation information that should have been done by the co-lead agencies as part of the NorthMet FEIS.

Financial Assurance

The FEIS does not provide an adequate level of information on financial assurance. The FEIS lists items for which costs must be included in the financial assurance instrument (i.e. demolition of all structures and remediation of sites, fencing the perimeters, sloping and seeding the overburden, constructing outlet structures, removing culverts, etc.) yet fails to provide any estimated costs or the basis for these costs. This section also notes that reclamation and post-reclamation costs are required yet fails to provide any estimated costs or the basis for their estimation (i.e. quantities, unit costs, inflation estimates).

The FEIS provides an initial estimate for 3 years of operation (Table 3.2-15). However, there is no basis for their estimation or other assumptions. The FEIS failed to provide detailed costs for the physical closure and reclamation of the mine site that will need to be covered by financial assurance instruments, a detailed discussion as to how much money will be needed from financial assurance instruments and when.

The basis for physical closure and reclamation costs need to be based on the private sector costs and include realistic profit margins when performing cleanup tasks. Cost to be covered by Financial Assurance need to include detailed information and cover the following areas: 1) interim operations and maintenance for agencies when a company declares bankruptcy and leaves the site, 2) water management and treatment, 3) removal of hazardous wastes and substances, 4) demolition, removal and disposal of facilities and equipment, 5) earthwork (sloping, backfill, grading), 6) re-vegetation, 7) long-term operations and maintenance, 8) Monitoring costs, 9) detailed inflation estimates, 9) provide a cash flow analysis, and 10) detail assumptions in the determination of risk and uncertainty.

The FEIS should have included the lifecycle of the pollution control structures built, estimates for their original construction costs, and projections for replacement costs for timeframes of hundreds to thousands of years. In addition to providing detailed cost estimation, the FEIS should have identified and communicated assumptions regarding inflation rates, rates of return, contingencies, and labor rates. Closure and maintenance costs will need to be covered years into the future, so a net present value should have been part of the FEIS.

For example, reverse osmosis is being proposed at the mine as a means of treating the mine's waste water and ensure compliance with water quality standards. Water treatment at this site is indefinite but will certainly be required for centuries. EPA has assessed reverse osmosis pollution control technology at mine sites within its Reference Guide to Treatment Technologies for Mining-Influenced Water published in March 2014 (EPA, 2014) and noted the following:

- Reverse osmosis is a proven method to demineralize acid mine drainage. However, it does require significant construction and operating costs.
- With pre-treatment and routine maintenance, membranes typically last two to five years and frequent membrane monitoring and maintenance are required to ensure the effective operation of a reverse osmosis system.
- Management and disposal of the brine solution that is generated can require higher operating costs. In arid climates, atmospheric evaporation may offer a technique for removing water in the brine solution followed by appropriate solid waste disposal. For locations where atmospheric evaporation is not feasible, thermal treatment may be needed. The FEIS states that the atmospheric evaporation technique would be used at NorthMet. However, the feasibility of this proposal has not been evaluated.
- Reverse osmosis is also in use at the Kennecott South site, which is located in the Salt Lake Valley, east-southeast of Copperton, Utah. The Bingham Canyon Water Treatment Plant (BCWTP), built as part of the site's remedy, is located in operable unit (OU) 2. Reverse osmosis is being used as the primary technology for addressing total dissolved solids- and sulfate impacted ground water.... The total cost for the BCWTP was about $16.1 million (2013 USD). Total yearly operation and maintenance costs (40 percent of these costs represent labor and 24-hour maintenance) for the BCWTP are about $1.3

million (2013 USD). These capital and yearly operation and maintenance costs include energy requirements, but do not reflect the costs associated with extraction wells, feed pipelines, disposal infrastructure and off-site disposal.

It is obvious that reverse osmosis requires high capital costs for the purchase, installation and operation of the membrane system. For a 1-million-gpd system, the total installed cost is estimated at $42.9 million (2013 USD). Annual operation and maintenance costs for the same system are estimated at $3.2 million (2013 USD). However, other features of the proposed mine will need to function indefinitely and must also be financially assured. The FEIS provides a listing of contingencies that may have to be covered by financial instruments including: 1) physical difficulties in implementing reclamation plans, 2) escalating standards of closure, reclamation, and long-term monitoring, 3) unanticipated liabilities, 4) unplanned cessation of mining, 5) failure of the mining company, and 6) failure or limitations on the ability of third parties to pay reclamation costs. Unfortunately the FEIS provides no discussion as to any of the costs of the contingencies that are identified. The FEIS also fails to discuss how financial instruments would be structured to meet those contingencies or the assumptions made by PolyMet to ensure an adequate stream of revenue is available to meet closure and maintenance costs.

What fundamental economic assumptions are being made when PolyMet proposes to use surety bonds, irrevocable letters of credit, cash and cash equivalents, trust funds, insurance policies, or a combination of these Financial Assurance Instruments? The FEIS failed to clearly state how the State of Minnesota will determine the maximum bond requirements, how it estimated direct reclamation costs, how it determined its estimates for inflation (i.e. periodic bond recalculation or calculate an Inflation factor using a common index, such as the Construction Cost Indexes (CCI) from the Engineering News Record), and how it will determine indirect reclamation costs and how it will calculate the total bond amount.

Historically, mining companies are temporary entities that disband soon after a mine project comes to an end. In reality, it is likely that PolyMet will not exist during post closure. The most reasonable scenario for long term closure is that a state or federal agency will be responsible for monitoring, maintenance, and cleanup activities because a mining company cannot be held accountable if it no longer exists. Similarly, the assumption that financial assurance instruments can be developed to ensure that funds will be available centuries from now is not logical. The State of Minnesota has existed for 155 years. The United States of America has existed for 237 years. The notion that a mining company and financial assurance instruments will be available to work on a mine site 500 years from now or longer, is not believable.

Please feel free to contact me or John Coleman in GLIFWC's Madison office – (608) 263-2873 if you have any questions or need further information.

Sincerely,

Esteban Chiriboga

Esteban Chiriboga
GLIFWC Environmental Specialist

Attachments

cc. Tamara Cameron, Chief, Regulatory Branch, Army Corps
Nancy Schuldt, Fond du Lac Water Projects Coordinator
Ken Westlake, USEPA Region 5
Mike Sedlacek, USEPA Region 5
Neil Kmiecik, GLIFWC Biological Services Director
Ann McCammon Soltis, GLIFWC Intergovernmental Affairs Director

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GLIFWC Review Staff

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Education

University of Alaska Fairbanks, Fairbanks, AK Fall 2004 – Summer 2010
Ph.D. in Biological Science, Focus Area: Wildlife Toxicology
(Cumulative GPA: 3.89/4.00)
Dissertation Title: Nutrients and Contaminant Dynamics in the Marine Food Web of Kotzebue Sound, Alaska

University of Rhode Island Graduate School, Kingston, RI Fall 1999 – Fall 2002
Completed 6 graduate level chemistry courses through a program for Pfizer employees
(Cumulative GPA: 3.55/4.00, non-matriculating)

College of the Holy Cross, Worcester, MA Fall 1995 - Spring 1999
B.A. in Chemistry, May 1999 (Cumulative GPA: 3.34/4.00)
Concentration: Biochemistry *Minor*: Philosophy
Thesis Title: Trace Gas Analysis of the Human Breath: Applications in Diabetes

Fellowships

National Institute of Health IDeA Networks for Biomedical Research Excellence (NIH-INBRE) Fellow, July 2005 – June 2009
University of Alaska Fairbanks Graduate School Thesis Completion Fellowship, September 2009-May 2010
Howard Hughes Undergraduate Research Grant, Summer 1998

Research & Professional

Great Lakes Indian Fish and Wildlife Commission Odanah, WI
Environmental Biologist September 2010 – Present

- Serve as PI of a 5-year EPA GLRI grant to measure mercury concentrations in tribally important fish species and to develop and communicate culturally appropriate fish consumption advice to GLIFWC's member tribes.
- Consult with tribes and provide guidance on toxicology issues, such as safe fish consumption, establishment of contaminant Total Maximum Daily Load (TMDL) criteria, and the impacts of mercury releases from metallic mines on fish, wildlife, and the environment.
- Review and provide written comments on research, reports, and proposed local, state and federal activities or regulations related to chemical contaminants that may impact tribes.
- Serve as a tribal representative on numerous regional, national, and international committees related to contaminant issues.

Institute of Arctic Biology, University of Alaska Fairbanks Fairbanks, AK
Research Assistant Summer 2005, Summer & Fall 2009, Spring 2010

- Essential and non-essential element status of Alaskan Dall's Sheep
- Heavy metal concentrations in clams from Hoonah, Alaska and exposure to human consumers
- Role of intestinal parasites in mercury dynamics of Alaskan wolves and seals

- Toxicodynamics of mercury in Alaskan sled dogs and their utility as models for human consumers of fish and marine mammal.

Pharmaceutical Research and Development Department, Pfizer, Inc. Groton, CT
Senior Associate Scientist July 1999 – July 2004

- Solid dosage formulation, solid-state chemistry research
- Experience leading multinational, inter-departmental teams

Committees and Workgroups

2006	Arctic Monitoring and Assessment Program (AMAP) Human Health Advisory Group
2010 – Present	Lake Superior Binational Partnership
2010 – Present	Lake Superior Binational Program Chemical Committee
2012 – 2013	St. Louis River Mercury Total Maximum Daily Load (TMDL) Modeling Workgroup
2012 – Present	Consultant to Michigan Technological University's (MTU) National Science Foundation Grant, "Managing Impacts of Global Transport of Atmosphere-surface Exchangeable Pollutants (ASEPs) in the Context of Global Change"
2013 – Present	Great Lakes Water Quality Agreement (GLWQA) Annex 3 (Chemicals of Mutual Concern) Subcommittee
2013 – 2014	National Fish Consumption Advisory Awareness and Effectiveness Guidance Document Workgroup
2013 – Present	Bemidji Area Tribal Environmental Public Health Advisory Committee

Teaching

Departments of Chemistry/Biology & Wildlife, U. of Alaska Fairbanks Fairbanks, AK
Graduate Instructor January 2010-May 2010

- Co-developed and taught a new course, Environmental Toxicology (available as upper-level undergraduate or a graduate level course)

Department of Biology & Wildlife, University of Alaska Fairbanks Fairbanks, AK
Teaching Assistant September 2004 – May 2005

- Principles of Biochemistry and Metabolism (BIOL 303)
- Wildlife Diseases (WLF 305)

Professional Societies

- Society of Environmental Toxicology and Chemistry (SETAC)
- International Association for Great Lakes Research (IAGLR)
- Invited reviewer of manuscripts for:
  - *American Journal of Physiology - Regulatory, Integrative and Comparative Physiology*
  - *Analytical Methods*
  - *Chemosphere*
  - *Environmental Science: Process and Impacts*
  - *International Journal of Circumpolar Health*
  - *Journal of Analytical Atomic Spectrometry*
  - *Journal of Environmental Monitoring*
  - *Journal of Marine Biology*
  - *Journal of Toxicology and Environmental Health Part A: Current Issues*

- *Metallomics*
- *RSC Advances*
- *Science of the Total Environment*

Research Interests

- Social and environmental justice aspects of environmental contaminants, with a focus on impacts to Native American and Alaska Native tribes
- Integrated risk-benefit analyses for the consumption of subsistence foods, balancing contaminant exposure risk with nutritional benefits
- Culturally appropriate communication of fish consumption advisories
- Chemical determinants of organic contaminant biomagnification and distribution
- Applications of dietary biomarkers to wildlife feeding ecology (fatty acids, stable isotopes, contaminant profiles)
- Linkages between wildlife and human health

Current and Recent Research Support

EPA Great Lakes Restoration Initiative Competitive Grant GL00E01452 (Principal Investigator)
Mercury Testing and Updating of Fish Consumption Advisories for Ojibwe Tribes of the Lake Superior Region
April 1, 2015 – March 31, 2020
This grant provided funds to continue the work described below for EPA GLRI Grant GL00E00613.

EPA Great Lakes Restoration Initiative Competitive Grant GL00E00613 (Principal Investigator)
Mercury Testing and Updating of Tribal Walleye Consumption Advice
September 1, 2010 – October 31, 2014
This grant provided funds for the collection and mercury testing of inland (walleye, muskellunge, northern pike) and Lake Superior (walleye, lake trout, siscowet, cisco, whitefish, burbot) fish species important to GLIFWC's member tribes. Results were used to update tribal, lake-specific Mercury Maps which provide consumption advice to GLIFWC's member tribes. A tribal safe fish consumption Outreach Program and associated materials were also developed and implemented under this grant.

EPA Great Lakes Restoration Initiative Capacity Grant GL00E00653
(Researcher, Environmental Biologist)
October 1, 2010 – March 31, 2016
The GLRI Capacity grant provides funds to build capacity for GLIFWC staff to participate in and bring a tribal perspective to the implementation of the Lake Superior Lakewide Management Plan (LaMP), Lake Superior Binational Program, Great Lakes Water Quality Agreement, and other Great Lakes initiatives. It also facilitates intergovernmental coordination among tribes and with other governments. Focus areas include contaminants, mining impacts, climate change, education and outreach.

Select Publications

1. Moses SK, Harley JR, Leiske CL, Muir DCG, Whiting AV, O'Hara TM. 2015. Variation in bioaccumulation of persistent organic pollutants based on octanol–air partitioning: Influence of respiratory elimination in marine species. *Marine Pollution Bulletin* 100(1): 122-127.
2. McGrew AK, Ballweber LR, Moses SK, Stricker CA, Beckmen KB, Salman MD, O'Hara TM. 2014. Mercury in gray wolves (*Canis lupis*) in Alaska: Increased exposure through consumption of marine prey. *Science of the Total Environment* 468-469: 609-13.

3. Monson BA, Staples DF, Bhavsar SP, Holsen TM, Schrank CS, Moses SK, McGoldrick DJ, Backus SM, Williams KA. 2011. Spatiotemporal trends of mercury in walleye and largemouth bass from the Laurentian Great Lakes Region. *Ecotoxicology* 20(7): 1555-1567.
4. Lieske CL, Moses SK, Castellini JM, Klejka J, Hueffer K, O'Hara TM. 2011. Toxicokinetics of mercury in blood compartments and hair of fish-fed sled dogs. *Acta Veterinaria Scandinavica* 53(1): 66-74.
5. Moses SK, Whiting AV, Bratton GR, Taylor RJ, O'Hara TM. 2009. Inorganic nutrients and contaminants in subsistence species of Alaska: Linking wildlife and human health. *Int J Circumpolar Health* 68(1): 53-74.
6. Moses SK, Whiting AV, Muir DCG, Wang X, O'Hara TM. 2009. Organic nutrients and contaminants in subsistence species of Alaska: Concentrations and relationship to food preparation method. *Int J Circumpolar Health* 68(4): 354-371.

Invited Presentations:

1. Moses SK. **Development of GLIFWC's Mercury-Based Tribal Fish Consumption Advice**. Monitoring Trace Metals in the Lake Superior Basin Conference (Odanah, WI). November 12-13, 2015.
2. Moses SK. **Mercury in the Environment and Food Webs.** North American Loon Symposium (Ashland, WI). October 25-26, 2014.
3. Moses SK, McCammon Soltis A, Kmiecik NE. **GLIFWC's Mercury and Fish Consumption Program.** Atmosphere-Surface Exchangeable Pollutants (ASEP) Workshop (Michigan Technological University, Houghton, MI). November 15, 2013.
4. Moses SK. **Contaminants in the Lake Superior Ecosystem.** Great Lakes Fishery Commission Upper Lakes Committee Meeting (Duluth, MN). March 19, 2013.
5. Moses SK. **Current levels and temporal trends of legacy contaminants and emerging chemicals of concern in the Lake Superior ecosystem.** International Association of Great Lakes Research 54th Annual Conference on Great Lakes Research (Duluth, MN). May 30 – June 3, 2011.
6. Moses SK. **Nutritional Hormesis: When good nutrients go bad.** Alaska Zoonotic Disease Center Seminar (Fairbanks, AK). April 22, 2009.
7. Moses SK. **Nutrients and contaminants in subsistence species of Kotzebue, AK**. Alaska Forum on the Environment (Anchorage, AK). February 4, 2009.
8. Moses SK. **Effects of food processing and tissue type on stable isotopes of carbon and nitrogen: Implications for studies of feeding ecology and mercury exposure.** Presentation to the laboratory of Dr. Gary Myers, University of Rochester School of Medicine and Dentistry (Remotely to Rochester, NY). December 10, 2008.
9. Moses SK. **Nutrients and contaminants in subsistence species of Kotzebue, AK**. Center for Alaska Native Health Research (Fairbanks, AK). October 10, 2008.
10. Moses SK. **Nutrients and contaminants in subsistence species of Kotzebue, AK**. UAF Environmental Chemistry Group Meeting (Fairbanks, AK). November 29, 2007.
11. Moses SK. **Linking wildlife and human health through nutrient and contaminant studies.** University of Alaska Biomedical Research Conference (Fairbanks, AK). April 12-13, 2007.
12. Moses SK. **Nutrients and contaminants in subsistence species of Kotzebue, AK**. March 2006 National Parks Service "Brown Bag" Seminar (Fairbanks, AK). February 13, 2007.
13. Moses SK. **Contaminants in subsistence diets of northern Alaska: Linking wildlife and human health in the Arctic.** 2006 Arctic Monitoring and Assessment Program (AMAP) Human

Health Expert Advisory Group Meeting: Contaminants and Arctic Human Health Symposium (Reykjavik, Iceland). May 9-10, 2006.

Other Presentations:

1. Moses SK, Lieske CL, Muir DCG, Whiting AV, O'Hara TM. **Influence of partitioning coefficients (K_{OW} and K_{OA}) on persistent organic pollutant (POP) patterns in gilled versus lunged arctic vertebrates**. University of Alaska Fairbanks Biology Graduate Student Association Symposium (Fairbanks, AK). March 25-26, 2010. [**Awarded "*Best Poster*"**]
2. Moses SK, Lieske CL, Muir DCG, Whiting AV, O'Hara TM. **Influence of partitioning coefficients (K_{OW} AND K_{OA}) on persistent organic pollutant (POP) patterns in gilled versus lunged arctic vertebrates**. 2009 Society of Environmental Toxicology and Chemistry (SETAC) North America 30th Annual Meeting (New Orleans, LA). November 19-23, 2009.
3. Moses SK. **Toxicological implications of mercury-selenium interactions**. University of Alaska Fairbanks Physiology Seminar (Fairbanks, AK). March 2, 2007.
4. Moses SK, Muir DCG, Whiting AV, Swor RM, O'Hara TM. **Nutrients and contaminants in spotted seals (*Phoca largha*) of NW Alaska: Linking the health of arctic mammals and subsistence users.** 2006 Wildlife Society Annual Meeting (Anchorage, AK). September 23-27, 2006.
5. Moses SK, Beckmen KB, Bratton GR, Taylor RJ, O'Hara TM. **Organic nutrients and essential elements in subsistence use arctic mammals: human health linkages.** 2005 Arctic Division of the American Association for the Advancement of Science (AAAS) Annual Meeting (Kodiak, AK) September 27-29, 2005.
6. Moses SK, Shamblin SL. **An approach for evaluating the susceptibility of two salt forms of a drug to process induced chemical instability.** 2003 AAPS Annual Meeting (Salt Lake City, Utah). October 26-30, 2003.
7. Moses SK, Van Doren JM, Cappuccio KL, Wszolek MF, Saint Cyr K. **Investigations of the kinetics of the reactions of O_2^+ and NO^+ with the isomers of $C_4H_{11}N$.** 217th ACS National Meeting (Anaheim, CA). March 21-25, 1999.

Additional Outreach

- **Interviews by Wisconsin Public Radio** on the Great Lakes Indian Fish and Wildlife Commission's program to measure mercury concentrations in tribally important fish species and communicate culturally appropriate fish consumption advice Native American tribes.
  - July 21, 2014 (http://www.wpr.org/research-finds-no-improvement-mercury-levels-northern-wisconsin-lakes) **Research Finds no Improvement in Mercury Levels in Northern Wisconsin Lakes.**
  - September 24, 2012 (http://news.wpr.org/post/mercury-presence-still-strong-walleye). **Mercury Presence Still Strong in Walleye.**
  - July 20, 2011 (http://www.wpr.org/great-lakes-restoration-initiative-after-one-year-part-1). **Great Lakes Restoration Initiative after One Year**.
- **Mercury Dynamics and Fish Consumption Advisories for Lakes in Iron County, Wisconsin.** Presentation to the Iron County Lakes Association (Mercer, WI). May 13, 2012.
- **Traditional Foods of Kotzebue, AK**. Aleutian/Pribilof Island Association (APIA) Subsistence Foods Workshop (Kotzebue, AK). December 3-5, 2007.
  - Presentation and ringed seal necropsy demonstration for community and students
- **Traditional Foods of Kotzebue, Alaska**. (Kotzebue, AK). January 12, 2007.

  - Lecture to Kotzebue High School students.
- **Interview featured in film:** ***Alaska Native Diet: Assessing the Benefits and Risks of Diet in Rural Alaska***, released in 2007.
  - Produced by the Aleutian/Pribilof Island Association to teach rural Alaska residents how to undertake studies to investigate nutrients and contaminants in their subsistence foods.

CURRICULUM VITAE

JAMES G. THANNUM

Work: Great Lakes Indian Fish and Wildlife Commission
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Position: Director of Planning and Development

PERSONAL INFORMATION

Born: June 9, 1959 in Hayward, WI. Married, one son age 21 and one daughter age 17.

EDUCATION

High School Diploma, Hayward High School, 1977.

Bachelor of Science with a double major in Business Administration and Environmental Economic Science.
Northland College, Ashland, WI. 1981
Graduated Cum Laude, Distinction in Business and Economics.

Additional career development courses were completed since college graduation in: Development of Business Plans, Wisconsin Real Estate Law and Appraisal, Advanced Strategic Planning, Implementing Organizational Strategic Plans, Association of Food and Drug Officials Seafood Safety HACCP course, FDA Seafood Inspection HACCP certification class, and Geographic Information Systems.

PROFESSIONAL EXPERIENCE

Director of Planning and Development — 2006 - Present
Great Lakes Indian Fish and Wildlife Commission
Odanah, WI.

Natural Resource Development Specialist — June 1986 - 2005
Great Lakes Indian Fish and Wildlife Commission
Odanah, WI.

Economic Development Administration (EDA) Planner — August 1981 -June 1986
Great Lakes Inter-Tribal Council (GLITC)
Lac du Flambeau, WI.

SUMMARY OF WORK EXPERIENCE

I have thirty-two years of experience in Socio-Economic Development and Community Planning and have assisted tribal governments in: 1) strategic planning, 2) contracting and administering federal, state and private foundation grants, 3) establishing management systems, 4) undertaking economic analysis and business development, 5) resource management and development, and 6) providing technical assistance to expert witnesses and plaintiff attorneys.

Strategic Planning: My work experience includes: 1) the development and implementation of an Overall Economic Development Plan for Bad River (1981-1986); 2) co-authoring the Great Lakes Inter-Tribal Council Overall Economic Development Plan (1986); 3) participating in strategic planning activities and assisting in drafting strategic plans for the Great Lakes Indian Fish and Wildlife Commission including the 2011 GLIFWC Strategic Plan entitled "Wii Gimawanjii'idimin Gaye Wii Nibawaadaanamin" (We will all meet together and we will dream); and 4) assisting the Bureau of Indian Affairs in completing an Office of Management and Budget (OMB) Program Assessment Rating Tool (PART) analysis that documented the efficiency and effectiveness of BIA natural resource programs nationwide. The OMB PART review and GPRA reporting requirements provide a key component of the federal budget development process. In addition, I have provided strategic planning assistance in the preparation of Congressional funding justifications

Contracting and Administering Grants: My work experience includes establishing interdisciplinary teams to write and administer grants and contracts from numerous funding sources including: 1) Community Development Block Grants (CDBG) from HUD; 2) Core Management, Forestry, Wildlife and Parks, Tribal [Resource] Management and Development, Fish Hatchery Operations, Noxious Weed Control, Rights Protection Implementation, and contract support 638 contracts with the Bureau of Indian Affairs; 3) Environmental Regulatory, Language and Social and Economic Development grants from the D.H.H.S Administration for Native Americans; 4) Agency for Toxic Disease Registry human health and fish contaminant testing research grants; 5) Environmental Quality Incentives Program (EQIP) and Wildlife Habitat Improvement Program (WHIP) grants from the USDA Natural Resource Conservation Service; 6) Great Lakes National Program Office, Coastal Environmental Management, Environmental Justice, EPA Star grants, and Great Lakes Regional Initiative grants from Environmental Protection Agency (EPA); 7) Great Lakes Fish and Wildlife Act research grants from the United States Fish and Wildlife Service; 8) Tribal Resources Grant Program COPS grants from the Department of Justice; 9) Wisconsin Conservation Corps grants; and 10) and private foundations.

Establishing Management Systems and Internal Capacity: My work experience included establishment of negotiated Lump Sum Agreements for the Bad River Band of Lake Superior with the U.S. Department of Interior's Office of Inspector General (i.e. to provide central management functions 1982-1986) and develop an annual tribal budget process.

I assisted the Commission in developing and refining an annual budget process to allocate 638 funding to meet requirements related to the implementation of off-reservation treaty rights. In 1991, I established a fixed carry-forward Indirect Cost Agreement for the Great Lakes Indian Fish and Wildlife Commission with the U.S. Department of Interior's Office of Inspector General (i.e. later named the National Business Center, and Interior Business Center). This enabled the Commission to obtain approximately $400,000 - $1,400,000 in additional funds annually to operate the Commission's basic management systems (i.e. accounting, property management/procurement, personnel administration, and record keeping). In addition, I worked with GLIFWC staff to submit Indirect Cost claims under Ramah class action suits and assisted the Commission and CPA's in meeting compliance requirements of the Single Audit Act. I also assisted the Commission in building the organization's physical and technological infrastructure including a new office facility, new equipment/garage storage, internet access, computer networks, Geographic Information Systems and Global Positioning System capabilities, and capital equipment replacement plans.

Business Development and Economic Analysis: Working for Great Lakes Inter-Tribal Council, my work experience included: 1) conducting management reviews and analysis to restructure the Bad River Bingo operation into a tribal enterprise with full accountability to the tribal council (1981-1986); 2) provided technical planning services to use components manufactured by the Tribal Sawmill and tribal labor trained through customized vocational programs to construct 11 three bedroom homes, a 1800 ft. two story wood products training center and a 1200 sq. ft. office/show room (i.e. structures currently used in the tribal casino operation) and a 1600 sq. ft. fire hall,(1981-1986); 3) provided technical assistance in structuring the Bad River Claim's Money Investment Plan that resulted in an investment of $1.2 minion to yield future interest/dividend payments for Socio-economic development projects with annual project approval by a vote of community members.

Working for GLIFWC, my work experience includes: 1) participating in Lake Superior whitefish and siscowet trout marketing initiatives with Michigan State University Sea Grant; 2) undertaking micro business development initiatives for tribal Lake Superior fishermen and wild rice processors; 3) teaching AFDO certified seafood safety courses with Michigan State University Sea Grant staff; 4) co-authoring After the Storm- Ojibwe Treaty Rights Twenty-Five Years After the Voigt Decision for GLIFWC's Minwaajimo (Telling a Good Story) symposium; and 5) review, analysis and commenting on the IMPLAN modeling analysis undertaken by UMD for the proposed PolyMet copper mine as part of the Supplemental Draft Environmental Impact Statement process.

Resource management and development: Working for Great Lakes Inter-Tribal Council, my work experience included: establishing and expanding the Bad River Natural Resource

Department through contracting Federal and State funds with staffing levels including a tribal biologist, two wardens, a tribal forestry aide, a seasonal fish hatchery crew, and Wisconsin Conservation Corps crew by 1986. Working for the Commission, I assisted GLIFWC biologists and conservation officers to expand capacity to monitor, protect and enhance treaty resources.

Technical assistance to expert witnesses and plaintiff attorneys: Work experience includes compiling data and technical information for expert witnesses and attorneys, preparing expert witness reports as required, and preparing questions for depositions and interrogatories. I provided a deposition in the *Modest Standard of Living* phase of *Lac Courte Oreilles v. Wisconsin* on November 9, 1987. I also provided a deposition in *Mille Lacs v. Minnesota* on April 17, 1996.

COMMITTEE/TASK FORCE ASSIGNMENTS

Wisconsin Tribal Conservation Advisory Council - Advisory member 2001- present

Michigan State University Sea Grant Great Lakes Whitefish and Siscowet Trout Marketing Steering Committee, 2004 - present.

Natural Resource Conservation Service State Technical Committee-Wisconsin, 1997- present

Bad River Building Committee, 1995-1997

Inter-tribal Agriculture Council, founding board member and Minneapolis Area Representative, 1987-1989

Bad River Indian Mills Board of Directors, 1986-1987

Bad River/Ashland County Committee Facilitator 1985-1986

Bay Area Rural Transit System Board of Directors, 1981-1983

PAPERS, REPORTS, AND PRESENTATIONS

After the Storm- Ojibwe Treaty Rights Twenty-Five Years after the Vogt Decision, 2011, Patty Loew and James Thannum, The American Quarterly, Volume 35, Number 2, Spring 2011.

State and Tribal Resource Management, 1999. This joint presentation was made with William Smith, Northern Regional Director, Wisconsin Department of Natural Resources at a joint Wisconsin Counties Association, Great Lakes Inter-Tribal Council conference on November 11, 1999. (Note article from the presentation is published in the Wisconsin Counties magazine's April 2000 issue.

An Analysis of Fishing License Sales Trends in Four Wisconsin Counties (Vilas, Oneida, Iron, and Sawyer) within the Chippewa Ceded Territory 1980-1995, 1995, this document was an Attorney work product for the Mille Lacs treaty rights litigation to reaffirm off-reservation treaty rights in the 1837 ceded territory of Minnesota.

Sokaogon Chippewa Community Long Range Strategic Plan for the Mole Lake Reservation, 1994, established a Mission Statement, Future Direction, and Long Range Goals for the Reservation through a strategic planning process.

1991 Chippewa Spearing Season, Building Cooperation and Bridging Conflicts, 1991, chronicled the social, economic, and resource harvest issues of the 1991 Chippewa spearfishing season.

1990 Chippewa Spearing Season-Conflict and Cooperation, the Two States of Wisconsin, 1990, chronicled the social, economic, and resource harvest issues of the 1990 Chippewa spearfishing season.

1989 Chippewa Spearing Season-Separating Myth from Fact, 1989 addressing misconceptions that Chippewa spearfishing was damaging northern Wisconsin fishery resources.

The Evolution of Wild Rice Markets, presented at the Great Lakes Indian Fish and Wildlife Commission Annual Meeting, October 1987.

Integration of Tourism and The Sale of Reservation Products, presented at a public hearing before the Wisconsin Assembly Committee on Trade, Industry, and Small Business, August 11, 1987.

The Economic Fallacies of the Vogt Decision, presented at the Great Lakes Inter-Tribal Council Annual Meeting, July, 1987.

Great Lakes Indian Fish and Wildlife Commission Five Year Development Plan, 1987.Tribal needs assessments were completed identifying priority areas for expansion of GLIFWC Enforcement, Public Information, Biological, Tribal Court, Inter-Governmental Affairs, and Planning and Development Services.

Report on Tribal Lake Superior Commercial Fisheries, 1987, The report reviewed trends, constraints, and development potentials for commercial fisheries for tribal fishermen to expand awareness of macro-economic and political developments.

Economic Assessment of Under-Utilized Furbearer Species, 1986. The report compiled general fur harvest and marketing data from trapping publications, National Trapping Association, DNR, Wisconsin Trappers Association, and provided fiirbuyer lists to tribal trappers.

Great Lakes Inter-Tribal Council Overall Economic Development Plan, 1986. Co-authored the OEDP as per guidelines of the Economic Development Administration identifying economic development activities for the Bad River, Red Cliff, St. Croix, Lac Courte Oreilles, Lac du Flambeau, Mole Lake, Stockbridge-Munsee, Oneida, and Winnebago Reservations in Wisconsin.

CDBG Housing Rehabilitation Manual, 1983, The CDBG Housing Rehabilitation Manual established a management system insuring compliance with H.U.D. Technical Assistance subcontract to GLITC.

Bad River Overall Economic Development Annual Report, 1981-1986.

Esteban D. Chiriboga

Phone: 608-263-2873
Email: esteban@glifwc.org

EDUCATION:

- Master of Science in Geography, 1998
  University of Wisconsin – Madison
  Madison, WI 53706

- Bachelor of Arts in Geography with minors in Geology and International Studies.
  Indiana State University
  Terre Haute, IN 47809
  Honors: G David Koch Memorial Award – Awarded for outstanding scholarship and professional growth as a student of Geography and Geology.

WORK EXPERIENCE:

Great Lakes Indian Fish and Wildlife Commission (GLIFWC) and Honorary Fellow, Land Information and Computer Graphics Facility, University of Wisconsin – Madison

Land Information and Computer Graphics Facility
University of Wisconsin – Madison
550 Babcock Dr. Rm. B-102
Madison, WI 53706
Employed from 1/1998 to present.

Environmental Specialist / Geographic Information System (GIS) Mapping and Mining Specialist
Responsible for the planning, management, implementation, and reporting of a wide variety of environmental, cartographic, GIS, physical geography and biological monitoring projects and provide general GIS support to GLIFWC staff. Specific projects include:

- Review of the accuracy and adequacy of environmental impact statements and supporting technical documents for proposed metallic mining projects and development of comments from a GLIFWC tribal perspective. The projects reviewed include the proposed Crandon Mine, Flambeau Mine, Lynne deposit exploration project, and Bend site exploration project in Wisconsin. The Eagle Mine, proposed Copperwood Mine, White Pine Mine expansion and Humboldt mill reactivation in Michigan. Proposed NorthMet Mine, MINNTAC Mine, UTAC Mine, and copper exploration projects in

Minnesota. Field data collection of water quality parameters and biomonitoring activities using wild rice as a bioindicator.

- Tribal Representative on the Wisconsin Geographic Information Coordination Council (WIGICC). Provided technical expertise to the council and assisted in the coordination of geospatial data gathering projects.
- Tribal Representative on the Wisconsin Initiative on Climate Change Impacts (WICCI). Participated in the development of the first Adaptive Report for the state. Provided information on climate change impacts from a tribal perspective and participated in the Water Resources Working Group.
- Assessment of the potential environmental impacts of mining operations on tribal resources using GIS techniques.
- EPA STAR Grant Mercury Consumption Advisory Maps. Responsible for designing and creating the GLIFWC fish consumption advisory maps that are distributed to tribal spearers.
- Buffalo Reef and Substrate Mapping Project. Principal Investigator. Responsible for coordinating sonar data collection with the National Water Research Institute of Canada and developing maps of the spatial relationship of stamp sands and Buffalo Reef, an important fish spawning site.
- Mapping of Fish Spawning and Nursery Areas of Lake Superior. Principal investigator. Responsible for digitizing and attributing fish spawning site data. GIS coverages were presented to federal, state, and tribal agencies. Maps can be viewed online at http://www.lic.wisc.edu/glifwc/lake_superior.html.
- Mercury contamination in fish database development and consumption advisory map design. Principal investigator. Compiled contaminant databases from data obtained from state and federal agencies. Data was used to develop GIS maps illustrating tribal fish consumption advisory. Maps can be viewed online at http://www.glifwc.org.
- Mapping of Aquatic Invasive Species. Compiled available aquatic invasive species data from state and federal agencies and developed GIS coverages and thematic maps of the data. Assisted in the development of the GLIFWC online mapping service for invasive species. Online maps of invasive species can be viewed at http://www.glifwc-maps.org.
- Mapping geographic place names in Ojibwe Language. Created a database structure of traditional Ojibwe place names and created maps for posters and atlas publications.

Wisconsin State Cartographers Office (SCO)
550 South Park St.
Madison, WI 53706
Employed from 6/1997 to 1/1998

Project Assistant
Responsibilities included the management and expansion of the SCO World Wide Web site, the Wisconsin Land Information Clearinghouse (WISCLINC), and the collection and compilation of geospatial metadata records.

Department of Geography: University of Wisconsin – Madison
550 South Park St.
Madison, WI 53706
Employed from 8/1995 to 5/1997

Teaching Assistant
Responsibilities included teaching three physical geography lab sections per semester. Topics covered in these labs included general physical geography (climatology, biogeography, soils, fluvial geomorphology, and glacial geomorphology) and the reading and interpretation of maps and aerial photographs.

Indiana State University / U.S. Fish and Wildlife Service
Indiana State University Science Hall
Terre Haute, IN 47807
Employed from 5/1993 to 12/1993

GIS Technician
Participated in the Indiana GAP Analysis Pilot Project as part of the Indiana State University team. Duties included the creation and maintenance of topography, vegetation and land use data layers as well as associated attribute databases and metadata files in a UNIX-Arc/Info environment.

PRESENTATIONS:

- Tribal Lands and Environment Forum, National Tribal Mining Workgroup: Mining in the 21St. Century, Minneapolis, MN, 2015
- Lake Superior Workgroup, Mining Committee Report, Terrace Bay, ON, 2015.
- Mining Alternatives Summit, Long Term Impacts of Metallic Mining, Red Cliff, WI, 2015.
- Wisconsin League of Women Voters Annual Meeting, Mining Related Surface and Groundwater Concerns, Ashland, WI, 2015
- Lake Superior Workgroup, Areas of Concentrated Mining Activity Along the Southern Shore of Anishinaabeg-Gichigami, Thunder Bay, ON, 2014.
- Bureau of Indian Affairs – Partners in Action Conference, Mining Panel, Prior Lake, MN, 2014.

- Lake Superior Technical Committee Meeting, Mining in the Anishinaabeg-Gichigami Basin, Red Cliff, WI, 2014
- Keweenaw Bay Indian Community Tribal Mining Forum, Mining Process and Impacts, L'anse, MI, 2012.
- International Association for Great Lakes Research (IAGLR), Mapping Mining activity in the Lake Superior Basin, Duluth, MN, 2011.
- EPA Region 5 Mining 101 Course, Where Mining is Planned and Possible in Region 5, Chicago, IL, 2011.
- Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Tribal Mining Conference, Mining Process and Impacts Workshop, Bad River Reservation, WI, 2011.
- Tribal Environmental Program Management Conference, Wisconsin Initiative on Climate Change Impacts (WICCI) Tools for Assessing Impacts to Tribal Resources, Chicago, IL, 2011.
- Society of Wetland Scientists/Wisconsin Wetland Association Joint Conference, Methods for Estimation of Indirect Hydrologic Impacts on Wetland Plant Communities at Potential Hardrock Mine Sites, Madison, WI, 2009.
- Indigenous Environmental Network: The Land, Sky, Water, and Culture, Mining Impacts on Tribes in the Western Great Lakes Region, Establishing Area of Potential Effect (APE) Under the National Historic Preservation Act and Impact Area of Influence (IAOI) or Area of Influence (AOI) under the National Environmental Policy Act as a First Step in Impact Analysis of Proposed Mine Projects, Carlton, MN, 2008
- Seventh Annual Surface Water Monitoring and Standards (SwiMS) Meeting, Monitoring the Distribution and Movement of Mine Wastes in Lake Superior, Chicago, IL, 2008.
- Eighth International Conference on Mercury as a Global Pollutant, Communicating Tribal Fish consumption Advisories Through Geographic Information Systems (GIS), Madison, WI, 2006.
- 2006 Regional Data Exchange Conference: Remote Sensing Across the Great Lakes, Mapping Mine Wastes in the Vicinity of a Spawning reef in Lake Superior, Rochester, NY.
- Western Mining Action Network, Using Mapping to Evaluate Impacts of Proposed Mine Projects in Areas of Cultural Importance, Coeur d'Alene, ID, 2005.
- Wisconsin Wetlands Association Science Forum, Web Based Mapping of Aquatic Invasive Species, Green Bay, WI, 2005.
- Invasive Plant Association of Wisconsin, Description of the North American Invasive Plant Mapping Standards, Stevens Point, WI, 2004.
- American Water Resources Association, An Inter-Agency Approach to the Development of a Tribal Fish Consumption Advisory, Lac du Flambeau, WI, 2003.
- Workshop on Mining Impacted Native American Lands, Visual Impact Assessments at the Proposed Crandon Mine, Reno, NV, 2003.
- Workshop on Mining Impacted Native American Lands, Establishing Baseline Environmental Quality Information at a Proposed Mine Site, Reno, NV, 2003.

- Western Mining Action Network, Some Uses for Geographic Information Systems (GIS) in the Review of Mine Projects, Vancouver, BC, 2003.
- Society of Environmental Toxicology and Chemistry (SETAC), GLIFWC Walleye Consumption Advisory for Mercury, Trout Lake, WI, 2003.
- Society of Environmental Toxicology and Chemistry (SETAC), Heavy Metals and Other elements in Wild Rice, Trout Lake, WI, 2003.
- Wisconsin Land Information Association Annual Conference, Tribal Fish Consumption Advisory and Maps, LaCrosse, WI, 2000.
- North American Program, Land Tenure Center, Who Owns America? II Conference, Treaty Protected Tribal Natural Resources, Madison, WI, 1998.

PUBLICATIONS:

- Bennett, J., Esteban Chiriboga, John Coleman, Don Waller, 2000, Heavy Metals in Wild Rice from Northern Wisconsin, *The Science of the total Environment*, Vol 246, pp. 261-269.
- Groetsch, K., Brooke, L., Kolodezjski, E., Chiriboga, E., Coleman, J. 2003, Investigations into Walleye Mercury Concentrations Related to Long Standing Reservoirs Water Quality, Wetlands and Federal Energy Regulatory Licensed Dam Operation.
- Coleman, J., Chiriboga, E. 2007. GLIFWC Crandon Mine Technical Review: State of the Site Report. Great lakes Indian Fish and Wildlife Commission.
- Madsen, Eric R., Adam D. deWeese, Neil E. Kmiecik, Jeffery A. Foran, and Esteban D. Chiriboga, 2008, Methods to Develop Consumption Advice for Methylmercury-Contaminated Walleye Harvested by Ojibwe Tribes in the 1837 and 1842 Ceded Territories of Michigan, Minnesota, and Wisconsin, USA, *Integrated Environmental Assessment and Management*, Vol 4, No 1, pp. 118-124.
- Chiriboga, E. and Mattes, W, 2008. Buffalo Reef and Stamp Sand Substrate Mapping Project. Great Lakes Indian Fish and Wildlife Commission.
- DeWeese, Adam D., Neil E. Kmiecik, Esteban D. Chiriboga, and Jeffery A. Foran, 2009, Efficacy of Risk Based, Culturally Sensitive Ogaa (Walleye) Consumption Advice for Anishinaabe Tribal Members in the Great Lakes Region, *Risk Analysis*, Vol 29, No 5, pp. 729-742.

EPA APPROVED QUALITY ASSURANCE PROJECT PLANS

- Quality Assurance Project Plan for "Great Lakes Indian Fish and Wildlife Commission Buffalo Reef and Substrate Mapping Project." EPA Grant 96540801-0, 2005. QAPP detailed the collection methods and protocols for the sonar sounding of the lake bed and the fisheries assessments on the spawning reef.

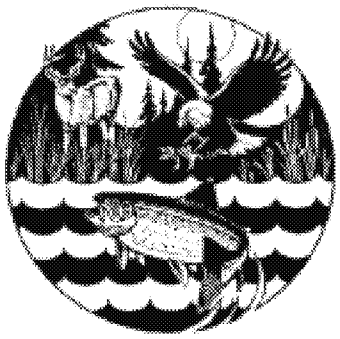
- Quality Assurance Project Plan for "GIS Mapping of Lake Superior Spawning and Nursery Areas." EPA Grant GL2000-130, 2001. QAPP detailed the methods used to digitize the "Atlas of Lake Superior Fishes" into GIS compatible data.
- Quality Assurance Project Plan for "GLIFWC Testing of Fish for Mercury." EPA Grant GL96540801-0, 2004. QAPP detailed the collection, testing and reporting of fish samples from inland lakes in the 1837 and 1842 ceded territory.
- Quality Assurance Project Plan for "Great Lakes Indian Fish and Wildlife Commission Wild Rice, Mussels and Fish Contaminant Monitoring Near Potential Mine Sites in Northern Wisconsin." EPA Grant X995574-01-02, 2001.

GREAT LAKES INDIAN FISH AND WILDLIFE COMMISSION

P. O. Box 9 • Odanah, WI 54861 • 715/682-6619 • FAX 715/682-9294

• MEMBER TRIBES •

MICHIGAN	WISCONSIN		MINNESOTA
Bay Mills Community	Bad River Band	Red Cliff Band	Fond du Lac Band
Keweenaw Bay Community	Lac Courte Oreilles Band	St. Croix Chippewa	Mille Lacs Band
Lac Vieux Desert Band	Lac du Flambeau Band	Sokaogon Chippewa	



Name and Address:

John Coleman
Great Lakes Indian Fish & Wildlife Commission at the Land Information & Computer Graphics Facility, University of Wisconsin - Madison
550 Babcock Drive
Madison, Wisconsin 53706
608 263-2873 (office) 608 262-2500 (fax)
e-mail:jcoleman@glifwc.org

Position:

Honorary Fellow, Land Information and Computer Graphics Facility, U.W. - Madison. 1995 to present.
Environmental Modeler, Great Lakes Indian Fish and Wildlife Commission. 1994 to present.
Environmental Section Leader, Great Lakes Indian Fish and Wildlife Commission. 1997 to present.

Education:

Ph.D. in Wildlife Ecology; minor in Statistics, 1994 U. of Wisconsin., Madison.
M.S. in Fisheries and Wildlife Science, 1985 Virginia Polytechnic Institute and State University (VPI & SU).
B.S. in Wildlife Management, 1980 University of Maine, Orono.

Professional Experience:

Mining and water quality specialist, Great Lakes Indian Fish and Wildlife Commission. Reviewed and commented on mining and mining exploration permit applications in the Chippewa Ceded Territories, of Wisconsin, Michigan, and Minnesota. Development of groundwater models for characterization of groundwater hydrology at multiple mine sites. Instructor in cooperation with USGS staff for groundwater modeling training focused on mine sites. Participated in development of non-ferrous mining regulations for Michigan. Participated as member of a cooperating agency on two federal EISs, providing advice on water quality, water quantity modeling, and fugitive materials control. Developed and implemented baseline water quality sampling programs at two mine sites. Developed and implemented sampling of biota at multiple mine sites to establish baseline concentrations of metals in biota.

Environmental data modeler, Great Lakes Indian Fish and Wildlife Commission. Collected and modeled data on surface and sub-surface natural resources in the Chippewa Ceded Territories of Michigan,

Wisconsin, and Minnesota. Emphasis on relationship between mineral development and surface plant and animal resources. Statistical modeling of spatial, temporal, and physical relationships. Mapping of spatial relationships. 1994 - present.

GIS Manager and Data Modeler, Great Lakes Indian Fish and Wildlife Commission and University of Wisconsin - Madison cooperative project. Modeled spatially referenced data to predict suitable habitat for pine marten and fisher. 1993 - present.

Research assistant, University of Wisconsin - Madison. Conducted a study of small mammalian predators. Focus on predation of songbirds. Collected, analyzed, and modeled data concerning the effects of landscape characteristics on predator behavior using feral domestic cats as a model species. 1988 - 1993.

Laboratory researcher in molecular genetics labs, Laboratoire de microbiologie, Lyon, France and Dept. of Zoology, U. of Leicester, England. Applied molecular techniques to wildlife conservation and biology. 1987 - 1988.

Wetlands manager, Florida Game and Fresh Water Fish Commission. Monitored changes in fish and vegetation species during restoration of a large channelized river. 1986.

Computer analyst, Virginia Polytechnic Institute and State University. Developed digital habitat maps from USGS, GIRAS geographic data base for a study of bald eagle movements and habitat use on the Chesapeake Bay. Helped develop and wrote documentation for radio-telemetry analysis software 1985-1986.

Researcher assistant, VPI & SU and the National Park Service. Planned, supervised, and collected data in a study of the ecology of black and turkey vultures in Pennsylvania. 1983 - 1985.

Publications and Presentations:

Coleman, J., Chiriboga, E. 2009. GIS based methods for estimation of indirect hydrologic impacts to wetland plant communities due to mine dewatering. Society of Wetland Scientists - Wisconsin Wetlands Association 2009 Joint Conference.

Coleman, J., Chiriboga, E. 2007. GLIFWC Crandon Mine Technical Review: State of the Site report. Great lakes Indian Fish and Wildlife Commission.

Coleman, J. S., DeWild, J. F., David P. Krabbenhoft, D. P., 2003.Cooperative Mercury Sampling of Surface Waters Near the Site of the Proposed Crandon Mine. American Water Resources Association. Wisconsin Annual Conference.

Coleman, J. S., Chiriboga, E. 2003. Establishing Baseline Environmental Quality Information at a Proposed Mine Site. U.S. EPA Workshop on

Mining Impacted Native American Lands. Reno, Nevada

Coleman, J. S., Chiriboga, E. 2003. Uncertainty in Prediction of Impacts to Groundwater Flow and Level from a Proposed Base Metal Mine. U.S. EPA Workshop on Mining Impacted Native American Lands. Reno, Nevada

Coleman, J. S., Chiriboga, E. 2003. Environmental Monitoring at the Proposed Crandon Mine Site. SETAC Conference.

Coleman, J. S. 1998. Visualizing the conceptual basis and results of a groundwater flow model using a Geographic Information System. American Water Resources Association, Wisconsin Annual Conference

Coleman, J. S. 1998. The importance of independence: Correctly identifying the independent variable when calculating rating equations. American Water Resources Association, Wisconsin Annual Conference

Coleman, J. S., J. Gilbert, J. Probst, and S. Ventura. 1995. Modeling suitable fisher habitat at a landscape scale in Wisconsin. Abstract, Second International *Martes* Symposium. Edmonton, Alberta.

Coleman, J. S. and S. A. Temple. 1993. A survey of owners of free-ranging domestic cats in rural Wisconsin. Wildl. Soc. Bull. 21:381-390.

Coleman, J. S. and J. D. Fraser. 1990. Southeast distribution and status of black and turkey vultures. Pages 78-88 in B. G. Pendleton, ed. Proc. Southeast raptor management symposium. National Wildlife Federation.

Coleman, J. S. and J. D. Fraser. 1989. Northeast distribution and status of black and turkey vultures. Pages 73-82 in B. G. Pendleton, ed.. Proc. Northeast raptor management symposium. National Wildlife Federation.

Coleman, J. S. and J. D. Fraser. 1989. Habitat use and home ranges of black and turkey vultures. J. Wildl. Manage. 53:782-792.

Coleman, J. S. and J. D. Fraser. 1989. Growth and age estimation of black vultures (Coragyps atratus) and turkey vultures (Cathartes aura). Wilson Bull. 60:197-208.

Coleman, J. S. and J. D. Fraser. 1988. Hematocrit and protein concentration of black vulture and turkey vulture blood. Condor. 90:937-938.

Coleman, J. S. and J. D. Fraser. 1987. Food habits of black and turkey vultures in Pennsylvania and Maryland. J. Wildl. Manage. 51:733-739.

Coleman, J. S. and L. Perrin. 1986. Preliminary analysis of changes in floating and submergent vegetation in the Kissimmee River demonstration project: some effects of water fluctuation and flow. Florida Game and Fish Comm. 8pp.

Coleman, J. S. and J. D. Fraser. 1986. Predation on black and turkey vultures. Wilson Bull. 98:600-601.

Coleman, J. S. and A. B. Jones III. 1986. User's guide to TELEM: Computer analysis system for radio- telemetry data. Dept. Fisheries and Wildlife, VPI & SU, Blacksburg, VA. 46pp.

Sweeney, T. M., J. D. Fraser, and J. S. Coleman. 1985. Further evaluation of

marking methods for black and turkey vultures. J. Field Ornithology. 56:251-257.

Coleman, J. S., J. D. Fraser, and C. A. Pringle. 1985. Salt-eating by black and turkey vultures. Condor 87:291-292.

Coleman, J. S., and J. Willmarth. 1980. Death Canyon, Grand Teton National Park, Wyoming (hack site report). The Peregrine Fund's western report 1980. pp. 57-66.

EPA Approved QAPPs

Quality assurance project plan for: Testing of fish for mercury under the Great Lakes Indian Fish and Wildlife Commission EPA STAR grant: "Reducing risks to the Anishinaabe from methylmercury." EPA Grant RD83104701/0, 2004. Involved development of an intervention program to reduce risks associated with subsistence-based consumption of walleye contaminated with methyl mercury.

Quality assurance project plan for: GLIFWC Testing of Fish for Mercury. EPA grant GL96540801-0 2004. Involved sampling of fish from inland lakes, testing of those fish for mercury and incorporation of the sampling results into GLIFWC's GIS based fish consumption advisory maps.

Quality assurance project plan for: Tribal Monitoring of Stream Flow in Swamp Creek, Forest County Wisconsin. EPA grant X-995574-01, 2003. Involved installation and operation of stream gages in cooperation with one of our member tribes and the USGS.

Quality assurance project plan for: Mercury in Surface Waters Testing Project Near the Crandon Potential Mine Site in Northern Wisconsin. EPA grant X995574-01-02), 2001 and 2002. Involved sampling and analysis of mercury and other metals in surface waters in cooperation with the Wisconsin DNR and the USGS.

Quality assurance project plan for: the Great Lakes Indian Fish and Wildlife Commission wild rice, mussels and fish contaminant monitoring near potential mine sites in northern Wisconsin. EPA grant X 995574-01-02, 2001. Involved field acquisition of plant and animal tissues for contaminant analysis, statistical analysis and spatial mapping of the contaminant results over multiple years.

Quality assurance project plan for: Great Lakes Indian Fish and Wildlife Commission Water Quality Baseline Sampling in Watersheds Potentially Impacted by Mining Activity. EPA grant GL00E00613-0, 2011. Involved field acquisition of water quality data through water samples, field measurement and automated data logging.